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AMERICAN WATER WORKS ASSOCIATION

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AMERICAN WATER WORKS ASSOCIATION

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Directory of Professional Services—pp. *53-58 P&R*

AWWA ANNUAL CONFERENCE

Chicago, Ill. **June 12-17, 1955**

All reservations are being cleared through the AWWA office. The hotels have agreed to accept no reservations for the 1955 Conference except as they are requested on the standard form, through the AWWA.

Coming Meetings

AWWA SECTIONS

1955

Jan. 18—New York Section Annual Winter Luncheon Meeting, Hotel Park Sheraton, New York. Secretary, Kimball Blanchard, Rensselaer Valve Co., 56 Grand St., White Plains.

Feb. 9—New Jersey Section Winter Luncheon Meeting, Hotel Essex House, Newark. Secretary, C. B. Tygert, Box 178, Newark 1.

Feb. 9–11—Indiana Section at Lincoln Hotel, Indianapolis. Secretary, Robert J. Becker, Asst. Supt. of Purif., Indianapolis Water Co., 113 Monument Circle, Indianapolis 6.

Mar. 21–23—Southeastern Section at DeSoto Hotel, Savannah, Ga. Secretary, N. M. deJarnette, Engr., Div. of Water Pollution Control, State Dept. of Public Health, 245 State Office Bldg., Atlanta 3, Ga.

Apr. 13–15—Nebraska Section at Cornhusker Hotel, Lincoln. Secretary, E. Bruce Meier, Asst. Prof. of Civ. Eng., Univ. of Nebraska, Lincoln.

Apr. 13–15—Kansas Section at Baker Hotel, Hutchison. Secretary, Harry W. Badley, Repr., Neptune Meter Co., 119 W. Cloud St., Salina.

(*Continued on page 8*)

Coming Meetings

(Continued from page 6)

Apr. 14–16—Arizona Section at San Marcos Hotel, Chandler. Secretary, Quentin M. Mees, Arizona Sewage & Water Works Assn., 721 N. Olsen Ave., Tucson.

Apr. 18–20—Canadian Section at Chateau Frontenac, Quebec. Secretary, A. E. Berry, Director, Ontario Dept. of Health, Parliament Bldgs., Toronto 8, Ont.

Apr. 20–22—New York Section at Hotel Statler, Buffalo. Secretary, Kimball Blanchard, Rensselaer Valve Co., 56 Grand St., White Plains.

Apr. 29–30—Montana Section at Finlen Hotel, Butte. Secretary, A. W. Clarkson, Acting Chief, Water Section, Div. of Environmental Sanitation, State Board of Health, Helena.

May 4–6—Pennsylvania Section at Webster Hall, Pittsburgh. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg.

May 19–21—Pacific Northwest Section at Hotel Chinook, Yakima, Wash. Secretary, Fred D. Jones, Dist. Supervisor, Rm. 305 City Hall, Spokane, Washington.

Sep. 7–9—New York Section at Saranac Inn, Saranac. Secretary, Kimball Blanchard, Rensselaer Valve Co., 56 Grand Street, White Plains.

Sep. 12–14—Kentucky-Tennessee Section at Phoenix Hotel, Lexington, Ky. Secretary, J. Wiley Finney Jr., Howard K. Bell, 553 S. Limestone St., Lexington.

Sep. 14–16—Michigan Section at Durant Hotel, Flint. Secretary, T. L. Vander Velde, Chief, Section of Water Supply, State Dept. of Health, Lansing 4.

Sep. 21–23—Ohio Section at Neil House, Columbus. Secretary, M. E. Druley, Dist. Mgr., Dayton Power & Light Co., Wilmington.

Sep. 21–23—Wisconsin Section at Hotel Schroeder, Milwaukee. Secretary, Leon A. Smith, Supt., Water & Sewerage, City Hall, Madison 3.

OTHER ORGANIZATIONS

1955

Mar. 7–11—National Assn. of Corrosion Engrs., at Palmer House, Chicago.

Mar. 28–Apr. 1—Western Metals Exposition, Pan-Pacific Auditorium, Los Angeles, Calif.

Apr. 5–7—Corrosion Control Short Course at Univ. of Oklahoma Extension Study Center, Norman, Okla.

May 15–19—European Assn. for Research on Fluoridation and Caries Control, Univ. of Geneva College of Dentistry, Geneva, Switzerland.

Jul. 11–16—Nuclear Engineering Congress, Engineers Joint Council, New York.

Jul. 18–23—International Water Supply Assn. Congress, London.

Sep. 18–22—New England Water Works Assn., Lake Placid Club, Lake Placid, N.Y.

Oct. 10–13—Federation of Sewage & Industrial Wastes Assns., Ambassador Hotel, Atlantic City, N.J.


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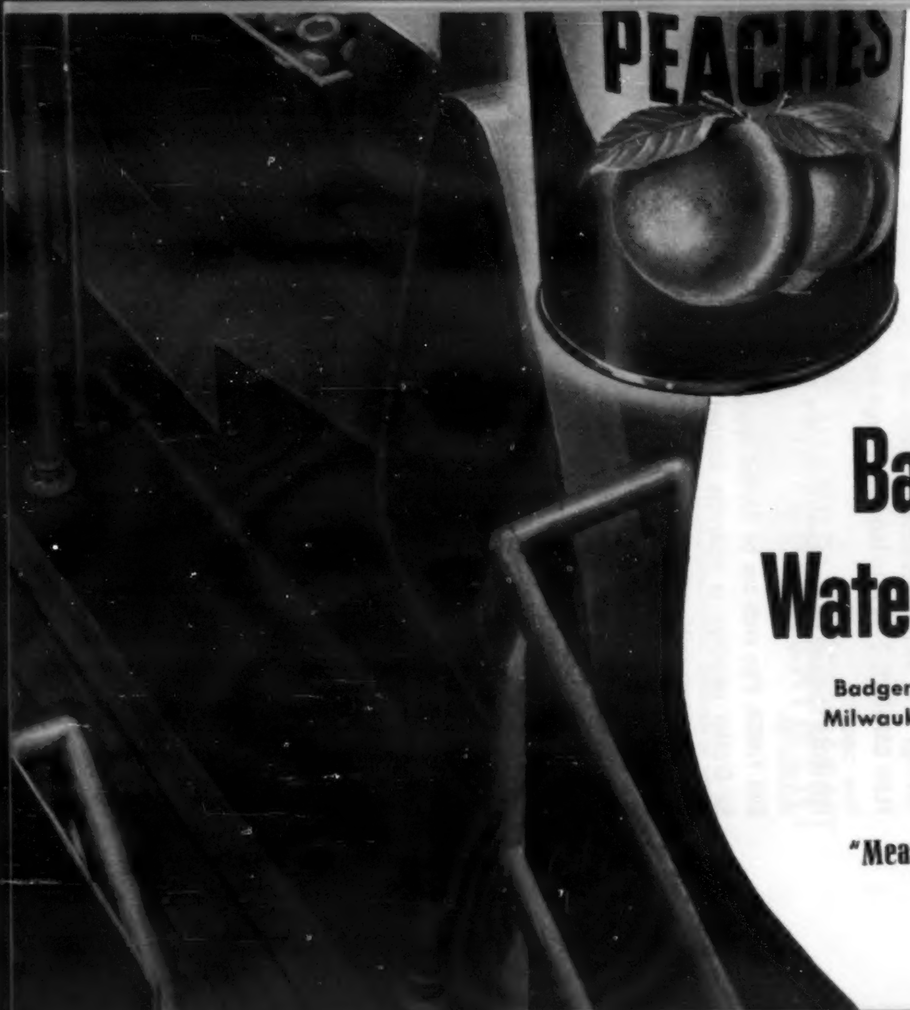

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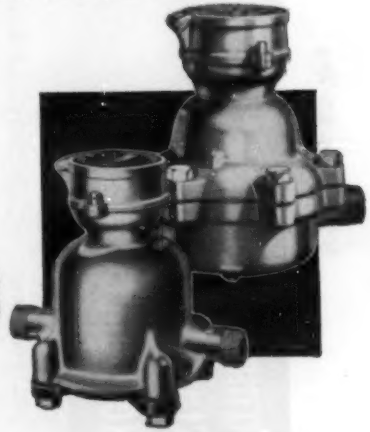

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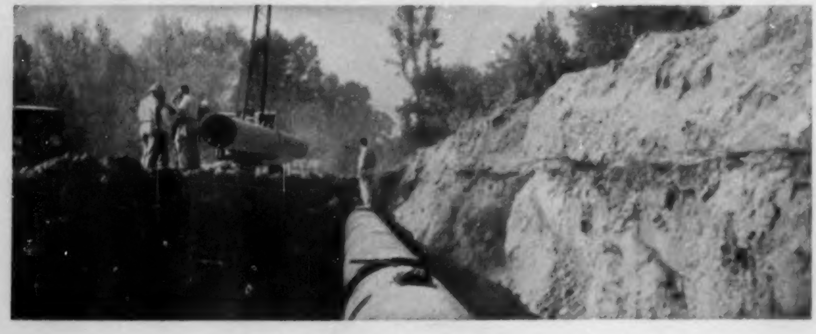

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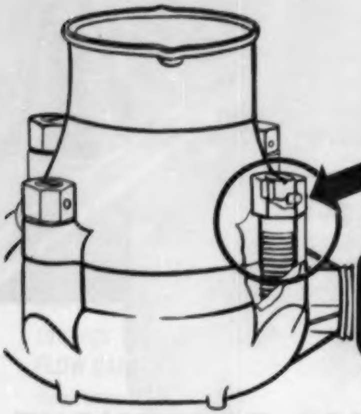

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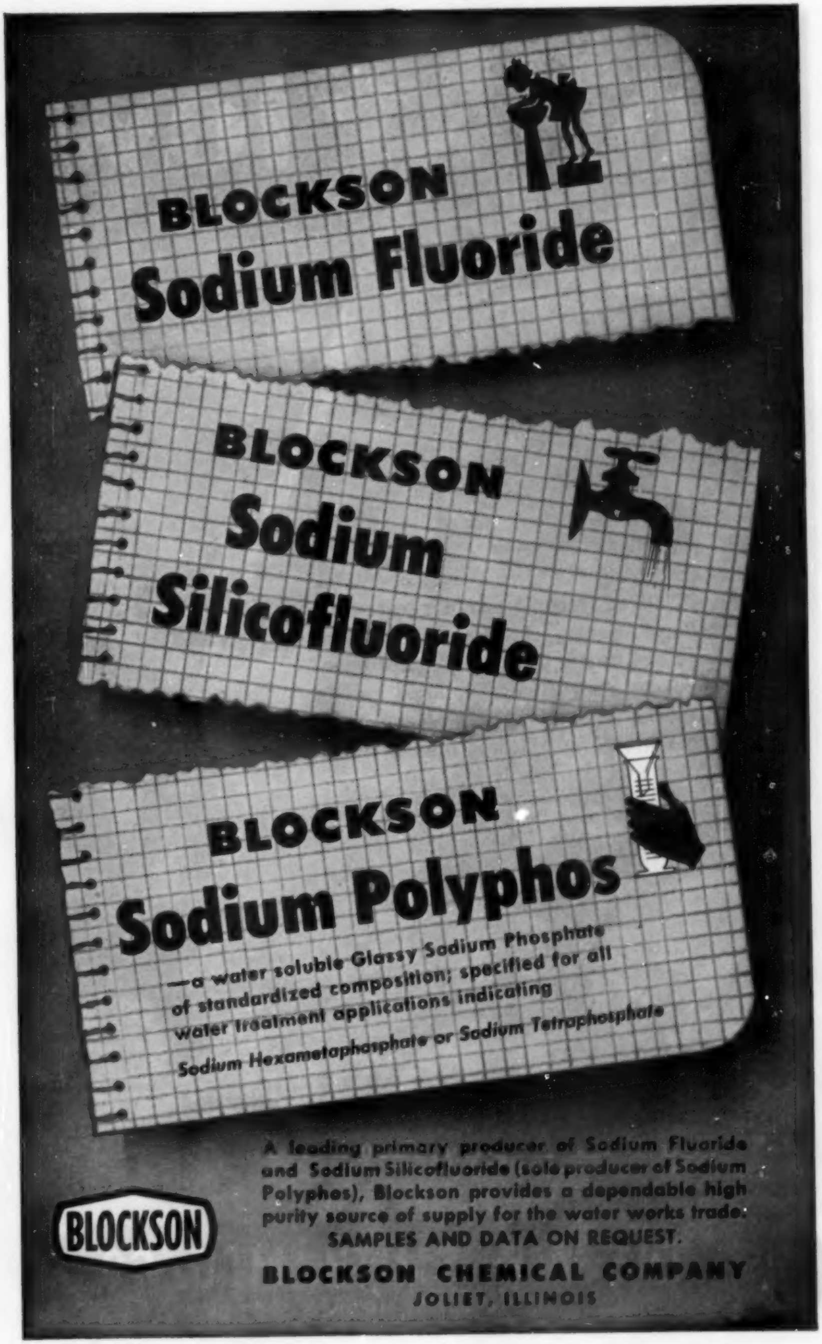
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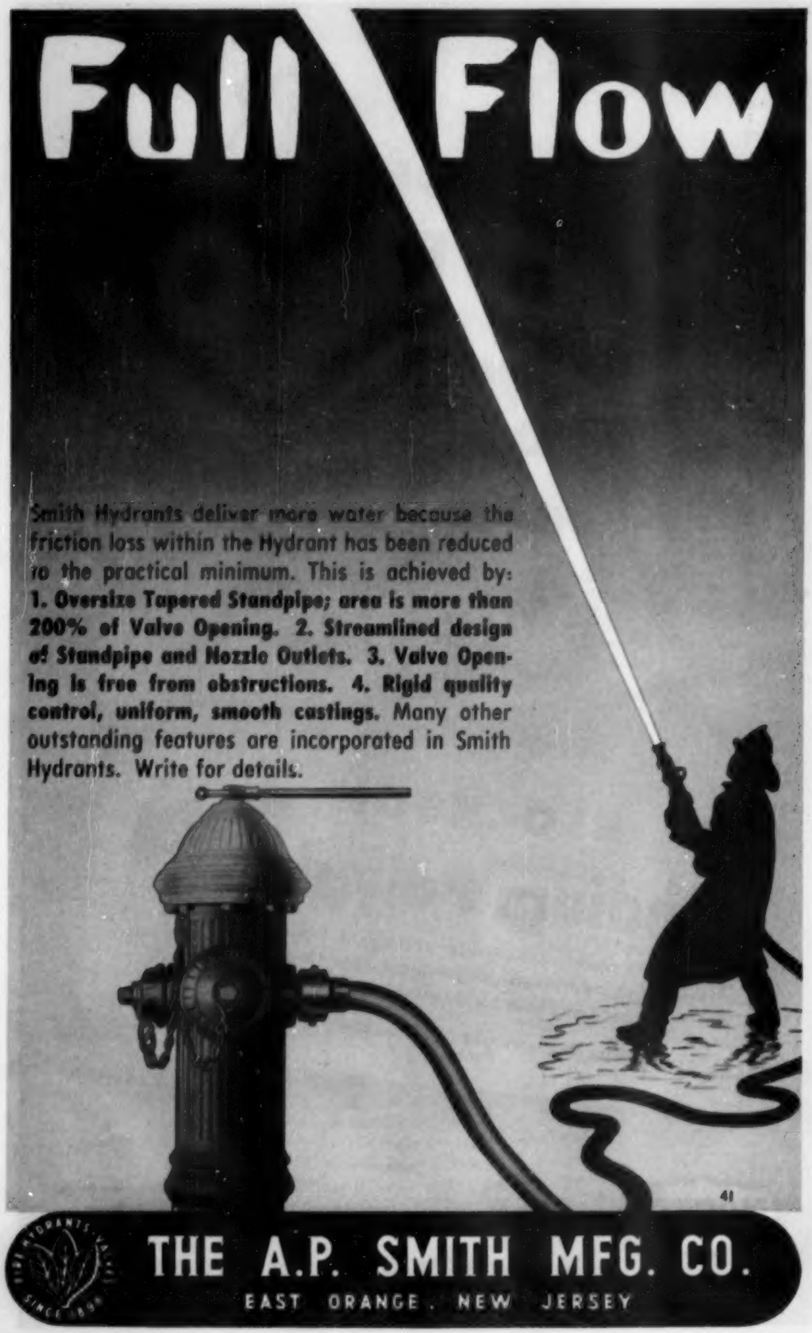
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Journal

AMERICAN WATER WORKS ASSOCIATION

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Providing Reasonable Water Service

Abel Wolman

A paper presented on Oct. 21, 1954, before the Pennsylvania Water Works Assn., Atlantic City., N.J., by Abel Wolman, Prof. of San. Eng., Johns Hopkins Univ., Baltimore, Md.

THE water works industry in the United States has had an enviable record of accomplishment and service. Water utilities, largely publicly owned and operated, have invested more than 7.5 billion dollars in essential facilities to provide adequate service for 100,000,000 urban consumers. In recent years the water works industry has expended in excess of $400,000,000 a year on new construction. This expenditure, relatively large though it is, has not been sufficient to keep pace with the requirements of the growing population.

In the United States, a sharp rise in the use of water since the end of World War II has not been accompanied promptly by increases in facilities to meet the demands upon them. These deficiencies in sources and in distribution are naturally accentuated when droughts occur during the same periods as increased demand. This was the situation in the summer of 1953, a somewhat dry year, which was followed, in most parts of the United States, by an even drier summer in 1954.

The inadequacies of service encountered in 1953 have been broadly described and diagnosed by the US Geological Survey (*1*). More than 1,000 systems reported a shortage, defined by the USGS as a situation in which the system was unable to supply the peak demands of customers and restrictions in the use of water were instituted. These difficulties were not confined to systems supplying small populations. Of the 93 systems serving more than 100,000 people, 35, or 38 per cent, experienced a shortage.

The USGS survey disclosed that 51 per cent of those systems reporting had shortages because of population growth and increased use; about 34 per cent, because of supply failure; and 14 per cent, because of a combination of these reasons. In the shortages experienced,

20 per cent were attributable to inadequate distribution facilities. A parallel survey conducted by AWWA in 1953 covered approximately 500 systems serving populations of 10,000 or more. Sixty-eight per cent of these needed additional treatment and distribution facilities, and 27 per cent needed additional sources. During that same year about 24,000,000 consumers were restricted in the use of water. Again, these restrictions were common to small and large communities.

In 1954 inadequate service was perhaps more extensively experienced than in 1953. Inadequacies prevailed in the Midwest, the Southeast, and the Southwest. Difficulties were faced by communities of all sizes, and restrictions in use were common.

Generally, the consumer was militantly unhappy with what he considered to be bad planning on the part of the water works. In the Jun. 25, 1954, issue of the New York *World Telegram,* for example, George Montgomery, a staff writer, opened his discussion of the water supply problem with these words:

> The shortsighted planning and the pinchpenny policies of many Greater New York water systems have handed the suburban home owner an annual lawn-browning headache that will cost him many millions to wash away. . . . The utilities apparently failed to realize the great interest in gardening—and, hence, the need for water—that would be generated by the move to the country; [and] the fact that the modern home is loaded with water consuming appliances like dishwashers and washing machines.

In Baltimore, writers in the newspaper letter columns were equally uncomplimentary and expressed vehement dissatisfaction with a municipal service that can supply more water than is needed in the winter but insufficient water in the summer. Bad tempers characterized the deficiency situations in every other part of the United States. Technical explanations for the objectionable nature of water service did not impress the general public, because they were not too well understood and, in some instances, were obviously not persuasive. Bans on sprinkling of lawns and gardens prevailed in many parts of the United States until the end of September 1954. In some water systems, these bans have been in force for 7 of the last 10 summers.

It is pertinent to point out that the average consumption of water, based on a sample of 548 water supply systems in this country, is now about 150 gpcd. In 1910 it was 100 gpcd. This rise should be borne in mind when the difficulties to be overcome are under discussion. Great as this increase has been, it is not nearly so great as the increased requirements of the individual for a variety of other, less important services.

The situation will not be improved without heroic measures in the immediate future. There is no hope of setting the clock back in regard to population to be serviced, water to be used, or peak requirements for normal demands. By 1960 the people to be served by public water systems will undoubtedly exceed 120,000,000. Legitimate per capita water use will slowly increase, even with the best water conservation measures which may be appropriately required.

Foreign Water Problems

As misery loves company, it may hearten the water works official in the United States to know that his headaches are more than matched in most foreign countries with public water supply systems. The London metro-

politan area, with its vast population, is confronted by increasing water use, a limited group of economical sources, and a future demand for water for about 10,000,000 thirsty consumers. There, too, population growth and increased installation of water-consuming devices are pressing the water works official for large expansions.

In Manila, inadequate water service is the subject of almost daily newspaper attack. Competent management has found it impossible to keep pace with the tremendous population growth, and there was a long delay in expansion prior to the liberation. Source and distribution problems confront this metropolitan area containing 1,500,000 consumers. Many of the suburban areas are frequently without water, while others receive service only during certain times of the day.

A large population in peripheral sections of Tokyo's municipal area is getting limited or no water service. A new source will probably not be available for another 2 years. Distribution difficulties are great. In Hong Kong, perhaps the most acute water shortage in the Orient resulted in service, even to fashionable hotels, only between the hours of 5 and 9 PM each day. The business of supplying a city of 2,300,000 people with water in the distribution system for only 4 hr a day is an enlightening one. New sources are under construction but probably will not be available until the end of 1956. The summer of 1954 was none too helpful in rainfall.

Inadequate water service, definitely unsatisfactory to the average consumer, is a problem not only in the United States but throughout the world.

Causes of Inadequate Service

1. *Wars, depressions, inflation, and scarcity of materials and of manpower* have operated to intensify the water service problem in this country. The responsibility for interference and delay rests with no single group. The intelligent consumer accepts such explanations as valid, but he looks to the same speeding-up process in the water works field that has been demonstrated to be feasible in many other industrial enterprises.

2. *Increased per capita use* has resulted from the development and widespread installation of many devices and improvements in homes and commercial establishments. Air conditioning, the increase in lawn sprinkling (due undoubtedly to the great overflow into the suburban areas), the washing machine, the dishwasher, multiple bathroom facilities, individual swimming pools, and other known and unpredictable products of American ingenuity are undoubtedly raising the average and peak water demand.

3. *Unprecedented industrial expansion* requires more and more water for old and new processes. This demand is likely to continue to increase, even with the best of conservation measures.

4. *Unexpected and unprecedented increases in population* have taken place in old cities and, to an even greater extent, in the metropolitan rings around them. To the water works man, this population growth, quite unparalleled throughout the nation's history, has supplied one of the major headaches. Although it is said that the population curve is likely to flatten out in the years to come, the water industry should not rest too optimistically on this hope. For example, the population gain from 1950 to 1954 in suburban areas of Connecticut, New Jersey, and New York has been 17.1 per cent. In several of these areas, such as Nassau and Suffolk counties in New York and Middlesex County,

N.J., there have been percentage increases, in the same 4 years, of 43.7, 37.4, and 24.6 per cent. These figures offer no great consolation for responsible water utility officials.

The water works industry has tended to assume that it is confronted with an insoluble problem, quite unlike that encountered by any other public service. Although the population of the United States has increased since 1920 by approximately 50 per cent, in the same period the per capita production of energy went up more than 500 per cent. By and large, this increased requirement has been adequately met by most of the public power utilities. The amount of water produced has increased only about 100 per cent in this interval. Water works men need to lift their sights greatly. Ernest T. Weir, Pres., National Steel Corp., has recently stated: "If we did not have today at least a 50 years' reserve of coal and ore ahead of us, I would not feel very safe." This comment from a leader in a collateral industry is not intended in any fashion to give a criterion for the water works industry. It does, however, represent the kind of thinking which prevails in a major industry responsible for supplying a commodity as rapidly and as regularly as the consumer desires.

5. *Decentralized and metropolitan growth* have been familiar phenomena in American life since 1910. The area and density of population spilling into the metropolitan fringe have been extended rapidly in the last 10 years. That this is a source of complex water service problems is no surprise, as such areas have not been geared to high standards of water service. It is equally true that no small share of the responsibility for this situation lies in the hands of official and practicing engineers.

6. *The inertia of the public* in arriving at prompt decisions for the expansion of water works facilities is likewise well known. It has been tacitly assumed that the interval between the conception of a program for meeting immediate necessities and the date for actual initiation of construction should be 10–20 years in average municipal practice. Such inertia need not remain undisturbed and unchallenged. By taking for granted that delays in execution are inevitable, the water works industry virtually sanctions the continuance of an undesirable situation.

7. *Restrictions on increases in water rates* have, in some instances, retarded expansions required for the provision of adequate service. It is frequently assumed that such increases in rates would be difficult to obtain. There are many indications that this fear is not borne out by customer attitudes. In Baltimore, for example, an "across-the-board" increase in water rates, approaching 50 per cent, was accepted by the community in 1951 with virtually no dissent. Similar accomplishments are on record in other communities where appropriate public education has been carried out.

8. *Prevailing water works opinion* over the last half century has perhaps had something to do with the situation in which the industry now finds itself. If there was a philosophy on water service, it encompassed high efficiency coupled with a perpetual emphasis on curtailment of use. It is true that this policy was always lightly qualified with footnotes to the effect that the reductions were pointed primarily at illegitimate or wasteful use, but it is difficult to recall a parallel case of systematic insistence upon selling less and less of a product.

The power industry, of course, has had to initiate curtailment of use on

many occasions, owing to roughly the same causes as those which have confronted water works. The power industry, however, did not make a virtue of this necessity. It always considered restriction of use as an undesirable commodity-marketing process. It would be interesting to know how the power consumer would respond to an almost continuous onslaught of suggestions that he use no electricity from 8 PM to 10 AM every day during the summer. Or how he might respond if he were deluged with suggestions that one bulb per house would be more desirable than a well lighted establishment. It must be remembered that coal, hydroelectricity, and even atomic-power fuel are limited and costly. Somehow the practitioners in these and other industries intend to keep service adequate to meet the requirements and desires of the paying, consuming public.

Nature of Reasonable Water Service

In recent years much discussion has filled the technical journals in the search for a definition of reasonable water service. These efforts at definition have ranged from the hope that reasonable water service would mean providing water for all parts of the land for all requirements at all times to definitions which rest rigidly upon a service of limited character, dominated primarily by the inflexibility of existing water rate policies. Neither of these extremes is likely to produce the greatest benefits for the customers.

Reasonable water service cannot ordinarily include the dramatic necessities of areas which simply have little or no water resources. The fact that water shortage is a characteristic of Death Valley need not be of overwhelming concern to the day-by-day purveyor of water in other parts of the country. This phase of the problem of water service is very well expressed in the following quotation from a Rand Corp. study (*2*):

> As so frequently happens, facts and sober analysis largely dissipate fears. Water is an economic resource, like any other. It will never be "short" in any absolute sense, since there is always more available—at a price. It is true [that] water stringency may limit growth of an area, but only in the same sense in which the limited availability of any resource may be a check upon growth. If a certain region ceases its expansion relative to the rest of the nation or the world for lack of easily available water, it means only that the natural advantages, of which the availability of water is one example, of that region have been utilized to their economic limit. The situation differs in no essential respect from instances in history in which a period of rapid relative growth of one region or another came to an end as the supply of such resources as land or coal was pressed to its economic limit.

The real problem of reasonable water service occurs, therefore, as the result primarily of artificial restraints, largely manmade. Critchlow (*3*) has recently summarized these restraints, in brief terms, in a newspaper interview: "There is no shortage. In a great many places, the trouble—lack of water due to low pressure—occurs because the mains are too small to meet the big demands of a dry spell." He goes on to suggest that municipal and private systems did not keep pace with the giant growth of the suburbs but sought cheaper, stopgap solutions with minimum expenditures that were bound to cause increasingly frequent restrictions on use. Almost every public statement of water main extension policy is prefaced by restrictive language. Negative policies rather than realistic, militant, positive programming have too often been the guide.

The water works industry should provide a service which is consistently and continuously available, even at peak demands and in anticipation of the requirements of expanding geographical areas. Such reasonable service must encompass the consumers' requirements for all modern water-using devices, including the growing demand for, and interest in, the use of water for gardening purposes. Such a specification by no means implies that the industry must accept wasteful uses of water, illegitimate diversions, inadequate payment, or unsound development of real estate.

Preparation for Reasonable Service

The translation of the above specification for reasonable water service into reality will require an arduous effort along a number of important professional fronts. The kind of service which most water works men would prefer to offer to the consumer, and which complies with the specification noted above, cannot be accomplished without reference to at least some of the following stages. The speed and skill with which these stages are reached and passed will determine when the consumer will be more satisfied with water service than he is today.

1. *Maintenance of continuing technical review.* The uses of water, the sources required, and the distribution facilities essential for reasonable water service should be under continuing scrutiny. Reviews every 10–20 years are too infrequent to meet the demands of the times. It is essential for the industry to scrutinize its problems and its solutions, if not week by week, at least year by year. Coupled with these reviews, similar assays of the financial aspects of water service will undoubtedly be required. The issue of financial restraints looms large in most discussions but is often used as an alibi rather than to diagnose the problem. It should be remembered, as Howson (*4*) has recently pointed out, that: [1] all water service is cheap; [2] the difference in cost between mediocre and excellent water service rarely exceeds a fraction of a cent per capita per day; [3] increased water rates simply enable water works to give better service; and [4] the cost of water is now comparatively the lowest ever experienced.

Murdoch (*4*) has expressed similar views in the following colorful language: "Until water works officials stop thinking and acting like managers of bankrupt bargain basements . . . and begin to adopt the attitudes of successful sellers of quality goods, the public will not understand the worth of water works service."

2. *Development of criteria of adequacy.* Many in the water works industry have been aware for years that there are no quantitative criteria of adequate and reasonable water service. This lack of specifications which might guide both the public and regulatory agencies needs to be given thoughtful consideration by professional societies. The fire underwriters have done yeoman service, over the years, in supplying virtually the only criteria of adequacy but would be the first to admit that their specifications are limited in scope. They have served, however, to upgrade the quality of service almost more than those of any other group. Utility commissioners and practicing engineers have still to meet this challenge, even though they have, in many instances, developed qualitative criteria of reasonable service which still remain to be translated into guiding principles for general acceptance.

3. *Development of public relations programs.* These must be extended

and must move from historically negative precepts to future positive development. Properly handled, such programs are of inestimable value to the public. Without them, it is doubtful whether the concepts expressed in this paper and elsewhere will make their way expeditiously with the consumer.

4. *Reconciliation of costs and income.* This aspect of the problem needs no further underscoring, as it has been discussed and elaborated upon for years. It is axiomatic that no service can be provided without appropriate financial return. There should be no misguided conception that a magic wand can dispense with adequacy of income.

5. *Provision of machinery for action in metropolitan areas.* One of the greatest omissions of the water works industry is in the failure to provide early and promptly enough for the machinery for engineering, administering, and financing water works development. The responsibility for this deficiency rests squarely upon all concerned—the consulting engineer, state agencies, the industry itself, and the public. Precedents for the establishment of appropriate means for dealing with the problem are extensive. Their introduction into most of the metropolitan areas of the country has faltered, over the last quarter of a century, primarily because of the absence of an active program for providing such machinery. The situation will not cure itself. The cure still awaits an aroused professional and citizen group.

Without the machinery for prompt action, it is difficult to see how the requirements of great population shifts are to be met. The population of Los Angeles County, for example, has shown a net gain of 738,880 since the federal census of 1950. This net gain in less than 4 years is about equal to the population of Pittsburgh or New Orleans. To service such an area without this machinery and at a leisurely pace would certainly result in chaos.

6. *Reexamination of improvement financing.* In 1921 Morse and Wolman (*5*) pointed out that capital improvements in water systems involved both public and private benefits. The authors further emphasized the fact that construction which is of value to all the community—and, hence, to all taxable property—included reservoirs, pumping stations, treatment works, supply lines, and large distribution mains. The payment for such capital investment, both in theory and in practice, should not and could not come out of current water rates. If these capital improvements were exclusively financed by water rates, only two results were to be anticipated. Either the rates would be excessively high, if appropriate capital expenditures were pursued, or else the necessary capital expenditures simply would not be made.

Of the major sources of revenue of a water works system—general taxation, special assessments, and water rates—the third has dominated the historical scene. Many reasons may be summoned up to account for the position of the water rate as almost the only source of revenue for water system construction and operation. This reliance upon the water rate alone, or in conjunction with the front-foot assessment, was never sound or equitable. The results of the use of only a single source of revenue are dramatically apparent throughout the country. It should not have taken a quarter of a century to show that necessary capital expenditures could not equitably rest only upon water rates. The community significance of a water system has been completely ignored in

most rate structures and water fiscal programs. The mere presence of a water works in a community is of value to all of the taxable property. That property which will benefit now or later should share a reasonable part of the cost of planned expansion.

Expansion in advance of reasonably anticipated service necessities could be materially eased if the areas in which such expansions are required are subject to modest property taxation. Only by such means is it probable that the necessities of the area may be anticipated with maximum speed. Pressure for immediate consumption revenue would be materially reduced. Likewise, the number of consumers immediately available to each foot of main would not be the sole criterion for expansion. The identifiable requirements of society would provide the basis for both design and income.

Most present methods of financing water works are restrictive in nature. They do not permit the most realistic and prompt planning, action, and financing. As stated (*6*) in 1953:

> All of us in public health and public administration have fallen down in two areas of effort. We have failed to develop the administrative and fiscal machinery necessary to provide the public amenities of water supply, sewerage, and sewage disposal in areas outside the political boundaries of individual cities. Efficient planning, with very few exceptions, declines as one moves out of the municipality itself into its metropolitan areas, and in turn from the metropolitan areas into the more rural counties. It virtually disappears on an intercounty basis. Here we encounter the absence of either or both a responsible official agent or a militant public interest and knowledge. The two, of course, are inseparable, whether in city, metropolitan area, or county.
>
> The tremendous growth in this country in the past decade will probably continue in the next decade, particularly in the metropolitan areas, and generally there is no organization to assure installation of conventional sanitation features. All down the line our official groups for one reason or another have failed to introduce or develop the planning that would have prevented retrogression in this area.

The magnitude of many of the suburban developments is such that the water department of the central city faces severe problems of financing the extensive water supply installations required. It is likewise undesirable to finance such works by the issuance of general-obligation bonds against the general credit of the city, unless there already exists a routine for doing so. The use of revenue bonds to finance suburban installations is a modern and appropriate method of handling the situation. If new legislative authority is required, it should be provided promptly. These measures, coupled with general taxation where necessary, would simplify the suburban utilities' finance problem in county areas.

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Importance of Mutual Confidence Among Public Officials

Edward C. Harding

A paper presented on Sep. 22, 1954, at the Kentucky-Tennessee Section Meeting, Nashville, Tenn., by Edward C. Harding, Edw. C. Harding Co., Cincinnati, Ohio; Member, Board of Directors, Northern Kentucky Sanitation Dist.

THE history of the Northern Kentucky Sanitation Dist., comprising seventeen towns and cities in Campbell and Kenton counties, is filled with instances in which close cooperation among the governing bodies of the several communities stands out as a prime reason for whatever success the district has achieved in intergovernmental relations. Before going into detail, some general observations may be in order.

When the United States was predominantly a rural nation and cities were small and not numerous, a few street lamps, thoroughfares passable for horsedrawn vehicles, a volunteer fire company, and a jail for Saturday night drunks were about all the governmental services that urban centers were expected to provide. Public utilities, health departments, traffic control, social welfare agencies, and a multitude of other modern municipal activities were almost nonexistent. The last half century has witnessed a tremendous change in this picture. Urbanization, with its profound political and economic changes has presented three great challenges: The first is to build creditable, efficient municipal governments capable of coping with the many-faceted technical problems of modern civilization. The second is to accomplish these objectives within the framework of federal and state constitutions and under prohibitions of obsolete laws enacted for a largely rural society. The third challenge is to find a satisfactory answer to the ever growing need for better, more efficient, and more equitable relationships between cities and other governments and the various branches thereof.

The magnitude of this third challenge is indicated by the fact that, according to the Kentucky Legislative Research Commission, there were 115,113 governmental units (federal, state, county, township, municipal, and district) in the United States in September 1952. In Kentucky alone, there were more than 800 such units. Thus, practically every governmental agency and function will, sooner or later, collide with others. There is little doubt that large cities will be left unharmed by such collisions as occur, but small communities—towns and cities that do not command the means, resources, and prestige to extend streets, sewers, water lines, and transportation facilities on their own terms—must negotiate, compromise, and persuade their neighbors to cooperate. And such teamwork will produce surprising results.

Sanitation District Plan

One of the vital services that a city must provide and maintain is a system of sewers to collect and carry off the domestic and industrial wastes of the community, either to a treatment plant or to a discharge point. Many cities do not have treatment facilities and discharge their wastes, untreated, into streams and lakes. Federal and state laws prohibiting this practice are now being enforced, with the result that many communities are faced with apparently insurmountable obstacles to compliance, the greatest being the lack of money to pay for constructing sewage works.

Improvements in transportation and communication during the past 25 years have played a part in the tremendous expansion of housing and commercial development in small suburban communities. The unplanned growth of such communities, however, leaves unsolved the problem of what to do about their sewage. Scattered and removed beyond existing sewer facilities, they now must, nevertheless, install approved sewage treatment and disposal facilities. The per capita cost of these installations can be reduced materially if outlying communities can be induced to join the central city or if the communities are sufficiently close together to cooperate in constructing a single facility. An example of such cooperation is provided by the Northern Kentucky Sanitation Dist., and the story of its birth and growing pains will show how a number of cities solved their common problem of waste disposal and, at the same time, will illustrate the potentialities of intergovernmental relations.

In 1945 it became apparent that, when the Ohio River Valley Water Sanitation Compact became a reality, it would impose obligations on towns and cities throughout the valley that could not be temporized or ignored. Eventually all communities in the eight states signing the compact would have to provide facilities to collect and treat sewage and industrial wastes before discharging them into the Ohio River. An appraisal of the probable effect that ratification of the compact would have on cities and towns in northern Kentucky was anything but encouraging. Eighteen separate communities located in two counties were involved. To comply with provisions of the compact, each would be required to construct additional sewers and a treatment plant, unless a better arrangement could be devised.

In anticipation of compact ratification, Kentucky, like other states in the group, had passed enabling legislation providing for the creation of sanitation districts by towns located in one or more counties. The possibility of forming a sanitation district in northern Kentucky was explored and found to be feasible. To be of any benefit, however, the district had to take in two counties and eighteen cities and towns, all of them with separate governments and with differing views on how their interests would be affected.

Obtaining Approval

It was necessary first to convince the county boards of health that ratification of the compact was only a matter of time, that the district plan was workable, and that the various cities could be induced to join. It was found that successful negotiations required personal contact. In matters of such importance, letter or telephone communi-

cation is not sufficient. Personal interviews may mean the difference between a favorable and an unfavorable reaction to a proposal.

The health authorities were finally persuaded, and certificates of propriety and necessity were executed by them for presentation to the Kentucky Board of Health. Then began a series of meetings and consultations with the governing bodies of the eighteen cities and other agencies involved, and with the professional elements concerned in an enterprise of this kind. These meetings took place almost daily for 2½ years.

The average member of the town council or other governing body of the smaller community is honest, conscientious, and anxious to do a good job. These exemplary qualities are, unfortunately, very often the only ones he can contribute to the deliberations. He works to support his family and has neither the time nor the opportunity to acquaint himself with matters that are not routine or easily understood. When anything new is introduced, he turns for counsel to others, who may not be equipped to help him and frequently are not too willing to embrace new suggestions. Much of the effort that is expended on this account could well be conserved for more constructive purposes. Some bad advice given to town councils during this period delayed the sanitary district project unnecessarily and brought disastrous consequences to two cities that refused to join. They now find themselves in a desperate situation, which they are asking the district to alleviate. The remaining sixteen communities eventually petitioned for the creation of a district. A charter was issued and officers were appointed.

Negotiations then had to be extended beyond state boundaries to the federal government and its multiplicity of agencies, departments, and bureaus. First the district attempted to secure a loan from the Community Facilities Branch of the Federal Public Works Agency, to finance an engineering study and to pay the cost of preparing plans and specifications if recommended. A federal grant was refused, but the district took advantage of a Kentucky law to levy and collect a tax of 5 cents per $100 valuation on real property for a period of 3 years, which netted a total of $167,000.

When the preliminary engineering report was received by the district board and its acceptance assured, copies were distributed to each of the governments and agencies that would be involved in the district's operation. Arrangements were made to hold sessions with each of these groups for the purpose of talking out the many objections, both real and imaginary, that develop so quickly and gain currency so readily in the absence of accurate and reliable information. These sessions produced an effect entirely unexpected, at least by the author. As the meetings continued, confidence in the officers of the sanitation district was engendered by the accuracy of the engineering data and other facts offered and by the logic attending their presentation. It was apparent that the people with whom the district was negotiating were becoming convinced that it was really a fine thing, that its officers knew what they were doing, and that they were sincere, able, and honest men. Much of the success and progress subsequently achieved can be attributed to the confidence that was

built up during the early days of the district's operation.

The lesson to be learned is that one must be able to see and appreciate the other fellow's point of view. It is not enough to be right theoretically on a certain subject or in a certain endeavor; other people must believe in that rightness in their own minds. To bring this condition about sometimes requires a great deal of effort, but it is worth it. The reward for the pains taken by the district's officers to get along with other governmental organizations is the complete and unquestioned confidence of many agencies with which the district has relations.

Obstacles to Progress

Obstacles and impediments have had to be overcome at every turn. As previously related, the district was at first unable to raise money, except for the pitifully small sum produced through tax collections. In order to carry on, it was necessary to borrow $500,000 from local banks on the signatures of the three district directors, the money to be repaid from the proceeds of a bond issue if one were ever sold.

The Korean War started the same month the bank loans were made. Work on the first section of the project was to begin in June 1951. As the National Production Authority issued an order controlling all metals on May 25, the district's contractor could not secure the steel with which to begin his work. Those who had business with the National Production Authority during the early weeks of that agency's operation will remember it chiefly for its poor intergovernmental relations. After helping the NPA to solve the mysteries of its own directives, the district finally was able to have the project declared essential, and the necessary materials were allocated, but the delay led to a $70,000 claim for work stoppage costs. When this matter had been adjusted, construction began.

The US Army Corps of Engineers had agreed to perform certain flood wall and sewer work as a joint project with the sanitation district. The 1952–53 appropriations for rivers and harbors were altered materially by the new Congress, however, and the sum of $1,400,000 previously appropriated for a flood wall section at Covington, Ky., was eliminated, making it impossible for the Corps of Engineers to carry out the terms of the agreement. Faced with the problem of building a separate sewer at an additional cost to the district of $248,000 or of attempting to have the appropriation for flood wall work restored, the district officers chose the latter alternative. The Senate Appropriations Committee listened patiently and sympathetically and restored the funds so that the program could proceed as planned.

The agencies of the county and city governments, which may include housing authorities, as well as the local offices of the state highway department, the Corps of Engineers, and various departments of health, are as anxious to contribute to community improvement and development as is consistent with their circumstances. Trying situations can often be remedied by having the proposal for a new measure come from a long established agency. Even though the district was a new agency, it gained a distinct advantage by presenting plans for a single-purpose project already worked out and in final form. Thus, the various governmental

agencies were able to devote their time and attention to a study of the concrete aspects of the project instead of having to deal with broad generalizations.

Project Details

The Northern Kentucky Sanitation Dist. is in operation, serving seventeen cities and a military reservation, with a total population of 139,000, and 96 industries, with an equivalent of 82,000 persons. The collector system comprises 27 miles of trunk and lateral sewers, six lift stations, hundreds of feet of tunnels, and three underwater river crossings.

Domestic and industrial wastes are delivered to a single treatment plant, which serves the entire area. The plant is designed to provide primary treatment, involving removal of settleable solids, plus chemical precipitation. With this type of treatment, chemicals are used only during periods of low river flow, thus reducing operating costs. Treatment units include a grit chamber, comminutors, chemical feeders and flash mixers, flocculators, and final settling tanks. Diffused-air flocculation permits the tanks to be used for pre-aeration without chemicals when the degree of treatment required is only slightly above that obtainable by plain sedimentation. During periods of normal river flow, flash mixers and flocculators are bypassed, and the plant is operated as a primary treatment plant with grit removal, comminution, and plain sedimentation. Sludge is dewatered on vacuum filters, and the cake is incinerated. The ash is discharged to the river, along with the treated effluent. At present the plant handles 26 mgd of raw sewage, a figure that will ultimately be increased to 46.8 mgd.

The district has a bonded indebtedness of $7,600,000, which will be retired with money received from sewer service charges. The district's income is estimated at $1,000,000 per year. The operating budget for 1954 was slightly over $279,000.

This system is the first to be constructed and placed in operation pursuant to the provisions of the Ohio River Valley Water Sanitation Compact. Its progress has been followed with considerable interest, and the project has received much favorable comment. Speculation concerning public reaction, particularly with regard to the payment of sewer service charges, has been widespread. So far the program has received the most commendable support from all quarters. This situation may be attributed to the care and attention given to the dissemination of up-to-date information to the public and to the agencies with which the district does business. The district management has endeavored not only to convince the people in northern Kentucky of the need for doing their share to clean up the nation's rivers, but also to encourage them to pay the cost willingly.

Need for Leadership

In dealing with governmental agencies for the purpose of carrying out a complex or novel enterprise, leadership is of paramount importance. Leadership can be either by an individual or by a group, but it must be present if success is to be achieved. The leader must know the end result of what he is striving for; he must know what to do to reach that point; he must have weighed the advantages and

disadvantages of what he wants to accomplish; he must have complete confidence in what he is doing and unswerving determination to get it done, or he had better not start. Finally, he must be prepared to appear before the representatives of governmental agencies and explain these matters clearly and concisely. If one goes before a group to discuss a proposal rather than to present it, the usefulness of the meeting will always be in doubt. No man succeeds in any worth-while enterprise unless he forces or persuades others to help him.

Few people command the authority to force others to do things against their will, but most can persuade others to hear them out. Beneficial objectives deserve to be considered fully. Community enterprises are the concern of all, but they depend for success upon good leadership and the mutual confidence among public officials that results from proper attention to intergovernmental relations.

Addenda to Lime Specifications

Footnotes are to be added to Sec. 1A and 4A of the Standard Specifications for Quicklime and Hydrated Lime—AWWA B202-54 (published as "Tentative" in the January 1953 JOURNAL, Vol. 45, p. 89).

The note to Sec. 1A—Scope reads:

> No provision is made for high-magnesium lime in this document for the specific reason that such lime is not suited to water softening.

The note to Sec. 4A—Methods of Testing reads:

> As a basis for contract agreement between users of AWWA specifications and producers of lime, any person using the AWWA specifications shall indicate in his contract proposal precisely what method of determining available lime he intends to use.

Organization and Operation of the Greater Winnipeg Water District

Harold Shand

A paper presented on Sep. 3, 1953, at the Minnesota Section Meeting, Winnipeg, Man., by Harold Shand, Asst. Gen. Mgr., Greater Winnipeg Water Dist., Winnipeg, Man.

THE cities of Winnipeg and St. Boniface are situated at the junction of the Red and Assiniboine rivers in Manitoba. The municipalities of East and West Kildonan lie to the north, St. James and Tuxedo to the west, and Fort Garry and St. Vital to the south. The town of Transcona is located about 5 miles to the east. Before the Greater Winnipeg Water Dist. came into being, Winnipeg supplied water to five of the municipalities now within the district, and St. Boniface supplied another. In this way eight of the nine municipal units that now comprise the district already had had some experience in cooperation. This fact probably facilitated the solution of problems of organization, finance, law, and politics, which frequently are more difficult than those of engineering in creating a utility district.

The source of the first water supply of Winnipeg, the Assiniboine River, was never satisfactory. Although the water was passed through pressure filters, there was always a suspicion of organic pollution. Most of the year the water had a disagreeable taste which could not be removed by filtering. Except in winter, the stream was so turbid that the filters were continually clogged.

St. Boniface obtained its first supply from a series of wells located near the water works pumping station. The average depth of these wells was 80 ft.

In 1899 the facilities of the Winnipeg Water Works Co. were purchased by the city, which changed the source of supply to wells and, in 1901, built the first lime–soda ash softening plant on the continent. Between 1900 and 1908 seven wells were dug. These averaged about 18 ft in diameter and varied in depth from 46 to 102 ft. Later, before the well system was abandoned, a number of 18-in. wells were drilled, extending northward from the city for several miles.

The sanitary quality of the ground water seemed to be satisfactory; frequent analyses gave no indication of contamination, but there was some danger that increased pumping might result in drawing the wells down below the level of the river. The water was clear, colorless, odorless, and cool. Its hardness and salinity gave it a marked taste. Because of the excessive hardness, the water was not very good for domestic use and often impossible to use for industrial purposes. Adequate softening proved unfeasible.

By 1906 it was evident that the ground water alone could not furnish a sufficient supply at proper pressure for domestic use, not to mention fire protection. This situation, coupled with the rapid increase in demand due

to the large immigration and the existing and prospective industrial plants, led the Manitoba legislature to establish the Winnipeg Water Supply Commission, which was charged with developing an adequate supply for the city. The commission engaged a board of consulting engineers, which, in its report of Aug. 20, 1907, recommended the Winnipeg River as a source of supply. The city council, however, took no action, chiefly because the city had assumed other financial obligations.

In 1912 the provincial public utilities commission, at Winnipeg's request, made further studies regarding a new supply. These pointed to Shoal Lake as the most desirable source. The report approving the scheme also contained the suggestion that adjacent municipalities might join in procuring this water for their common benefit. In due course, all the municipalities interested passed the resolution required and were admitted into partnership in the Greater Winnipeg Water Dist.

Construction of Aqueduct

In 1913 a board of consulting engineers, appointed by the city to find the best means of supplying the district with water from Shoal Lake, made the following major recommendations:

That Shoal Lake water is of excellent quality for domestic and for manufacturing purposes; that Shoal Lake can be depended upon to furnish all the water required for the Greater Winnipeg Water Dist. until the population shall have reached about 850,000, and, with the help of the Lake of the Woods, can furnish a practically inexhaustible supply; that this water be brought from Shoal Lake through a covered concrete aqueduct 84.5 miles in length (under open-flow conditions to within about 8 miles from St. Boniface, thence through a 5.5-ft reinforced concrete circular pipe under pressure to the eastern bank of the Red River, thence through a 5-ft cast-iron pipe in a tunnel under the river) and thence through a 4-ft reinforced concrete pipe to the city reservoirs at McPhillips Street; the total length of the aqueduct to be 96.5 miles.

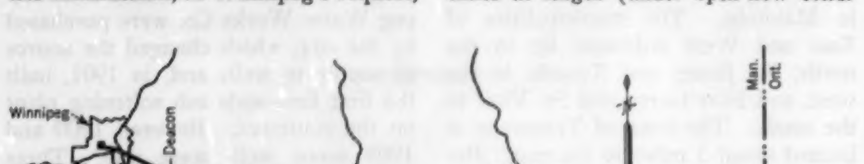

Fig. 1. Greater Winnipeg Water District Aqueduct

Nine Manitoba municipalities are supplied by this 85-mgd capacity aqueduct.

The structures as finally built conformed very closely to these recommendations. Table 1 gives some of the data on the Shoal Lake supply and general facts relating to the aqueduct.

A plan of the aqueduct is shown in Fig. 1. Although a comprehensive description of the aqueduct has been given in previously published articles (*1, 2*), certain features of the general plan may be reviewed here briefly.

As the Lake of the Woods is an international, as well as an interprovincial, body of water, it was necessary to apply to the International Joint Commission for approval of a diversion of water from Shoal Lake in Ontario for the district's needs. Hearings were held in 1913, and, in January 1914, the district was granted the right to divert a maximum of 100 mgd. The lake level is maintained between el 1,056 and el 1,061 (geodetic datum) by the Lake of the Woods Control Board.

The shores of the Lake of the Woods are virtually uninhabited. The district's water supply is not filtered, but Winnipeg adds sufficient chlorine to maintain a residual of 0.4 ppm, ammonia being used in a 1 : 5 ratio. During the summer Winnipeg employs copper sulfate and free residual chlorination, when necessary, to control algal tastes and odors. St. Boniface also uses chlorine and ammonia.

To aid in constructing the aqueduct, 110 miles (including sidings) of standard-gage railway tracks were laid. A railroad has been operated continuously since 1920, chiefly for patrol purposes but also to provide passenger, freight, and mail service to an increasing number of settlers in the area. The main source of revenue of the railway is the sale of gravel from the district's own pits. In 1952 the district excavated, hauled, processed, and sold 108,000 cu yd of this material.

TABLE 1

Data on Shoal Lake Water Supply

Preliminary estimate of cost of undertaking, exclusive of land and interest during construction	$13,045,000
Source of supply—Indian Bay, Shoal Lake, and Lake of the Woods	
Area of Shoal Lake	107 sq miles
Area of Lake of the Woods, including Shoal Lake	1,500 sq miles
Shoal Lake drainage basin area	360 sq miles
Lake of the Woods drainage basin area	27,700 sq miles
Difference in elevation between intake and Winnipeg Reservoir	290 ft
Method of delivery—gravity and booster pumping	
Area of Greater Winnipeg Water Dist.	58.14 sq miles
Population of Greater Winnipeg Water Dist., 1952	351,000
Length of cut-and-cover concrete aqueduct (85-mgd capacity)	77.5 miles
Length of river siphons and pressure section (85-mgd capacity)	7.1 miles
Length of reinforced concrete pressure pipe (50-mgd capacity)	9.4 miles
Length of Red River tunnel with 5-ft cast-iron lining	0.2 miles
Length of 4-ft concrete pipe in streets of Winnipeg	2.3 miles
Date work begun	Oct. 1, 1913
Date set for completion	Oct. 31, 1918
Date water entered McPhillips Street Reservoir	Mar. 29, 1919
Time (based on 30-mgd flow) for water to flow from intake to Winnipeg Reservoir	51 hr
Equalized assessment for 1952	$87,898,000
Levy for 1952	$560,000
Bonded indebtedness, Dec. 31, 1952	$9,279,112.83
Sinking fund assets, Dec. 31, 1952	$3,453,642.56
Average water consumption, 1952	76 gpcd

The intake structure receives water from Indian Bay, which is the west arm of Shoal Lake (Fig. 2). Within the structure are sluice gates in duplicate, each controlling one passage between the outer walls of the aqueduct proper; just above the gates is a double set of screens on each passage. Above the screens is a rack, and provision has been made for a wall of stop logs in each passage; stop logs are also provided for just west of each gate. Thus, it is possible, in either passage, to enclose a chamber that would include within it the screens and the sluice gate, permitting repair and cleaning. A small stream, the Falcon River, empties a highly colored water into Indian Bay, very near the intake. The district built a dyke across the west end of the bay and also a short canal at its southerly end to divert the river into an adjoining body of water, Snowshoe Bay.

There are eight river crossings. These are, in general, inverted siphons of reinforced concrete, built in the trench and designed with a head loss conforming to the average loss for the same distance in the horseshoe-shaped sections that they connect. The Red River is crossed by cast-iron pipe, 5 ft in diameter, set within vertical shafts lined with concrete and within a concrete-lined horizontal rock tunnel 10 ft square. The depth of the tunnel below ground surface is about 80 ft.

Upon the aqueduct on the east bank of the Red River, near the tunnel crossing, is a reinforced concrete surge tank. Its function is to protect the circular reinforced concrete section of the aqueduct east of St. Boniface from possible excessive pressures due to manipulation of the valve that controls the discharge into the city's reservoirs.

The aqueduct does not have a uniform discharge capacity throughout its length. At present it cannot deliver to the Winnipeg reservoirs the 85 mgd for which its main section is designed. The open-flow section, which is mostly of plain concrete, extends westward from the intake for about 80 miles and has a discharge capacity of 85 mgd. From the west end of this horseshoe-shaped section to Deacon, there is a depressed section of reinforced concrete, 8 ft in diameter and 4 miles long, which also has an 85-mgd capacity. Deacon, the site chosen for a future 250-mil gal reservoir, is about 8 miles east of St. Boniface and about 9.5 miles from the surge tank on the east bank of the Red River. Between these points and Deacon there is approximately 49,000 ft of $5\frac{1}{2}$-ft pipe with a capacity of about 50 mgd. A 5-ft tunnel crosses the Red River, and a 4-ft reinforced concrete pipe, 11,659-ft long, extends through Winnipeg to the reservoirs at its western end. This pipe has a capacity of 28.5 mgd under existing conditions.

The original plan called for the construction of a booster pumping station when Winnipeg's average daily consumption reached approximately 25 mgd, estimated to be about 1922. It was not until 1948, however, that the booster station was required. It has since been completed and is operated whenever the needs of Winnipeg cannot be supplied by gravity. The station is equipped with three 20-mgd pumps, with provision for a fourth. At present any two of the pumps may be operated in parallel, increasing the volume from 28-mgd gravity flow to 38 mgd.

Taxation

Interest and sinking fund requirements are met by an annual tax upon all of the lands (exclusive of improve-

Fig. 2. Aqueduct Intake

The intake is located on Indian Bay, the west arm of Shoal Lake.

ments) within the district. This unusual method of levying only on land for carrying charges probably developed because of the extremely rapid increase in population and, hence, in land values during the 30 years prior to 1913. It has since been realized that this tax burden on land is too heavy. The organization act provided that, in addition to the levy, a direct charge should be made for water, at the same rate for all member municipalities. As nearly as possible, the rate was to be based on the cost of maintenance, operation, and management of the undertaking. Originally the rate was 1.25 cents per 1,000 gal, but it was soon realized that the land tax should be decreased and a higher direct charge made for water. Consequently, an amendment to the act was secured, raising the rate to 5 cents per 1,000 gal, and the annual levy has been reduced from $1,242,000 (in 1922) to $560,000 (in 1952).

Water Distribution

Each municipality has its own distribution system and buys its water from the district in bulk, without pressure. The district, as a wholesaler, delivers the water to the point on the municipal boundary nearest to the aqueduct. Where necessary, the distribution mains of Winnipeg and St. Boniface are utilized for conveying water to adjoining municipal boundaries. The district pays 5 cents per 1,000 gal for the use of mains for this purpose. Only three of the nine municipalities—Winnipeg, St. Boniface, and Transcona—have pumping plants. The others purchase pressure, five from Winnipeg and one from St. Boniface. Winnipeg alone has storage reservoirs.

At the time of construction, takeoffs were provided for in the main conduit to serve all outlying municipalities if they should desire to do their own pumping. St. Vital, now served by St.

Boniface, has applied to the district for a direct aqueduct connection; this application has been granted, and contracts have been let for a 16-in. asbestos-cement pipeline and appurtenances. The costs of this line are to be shared equally by the district and St. Vital. The cost of a pumping station at the takeoff point will be paid for wholly by St. Vital.

Board of Equalization

For the purpose of defining the amount to be levied on the taxable land of each municipality included in the district, a board of equalization is required by the act. The board, which may function every year but must function at least every third year, consists of three members appointed by the public utilities commissioner at the request of the administration board. A new board is set up for each assessment. As its name indicates, the purpose of the equalization board is to place the land values in each municipality on an equal or uniform basis, as nearly as possible, rather than to accept the individual assessments of the municipalities as made by different assessors.

Administration

The powers and functions of the district corporation are exercised by an administration board consisting of representatives from the several member municipalities. Winnipeg is represented by five members of the municipal council, one of whom must be the mayor; St. Boniface, by the mayor and one other member of the city council; and the other municipalities, by their mayors. The mayor of Winnipeg serves as chairman. Subject to the authority of the administration board, the undertakings of the corporation are under the management of a board of commissioners, composed of three members, who devote only part of their time to this work, and a general manager, who gives his full time to the district.

Future Developments

The rapid increase in population during the last 10 years, particularly in the outlying municipalities, has posed a problem to all concerned. Winnipeg is undertaking a 20-year expansion program for new mains and pumping station improvements, amounting to \$300,000 per year. It is estimated that by 1963 the water district will be required to build a second 66-in. pipeline from Deacon to a point near the south boundary of Winnipeg, at a cost of \$5,500,000. At the point of delivery, Winnipeg plans to build reservoirs and a new pumping station.

With the construction of a direct supply line to St. Vital, St. Boniface will be relieved of 18 per cent of its present pumpage and, with existing equipment and mains, will be in a good position to serve its population for a number of years.

Some of the outlying municipalities, including St. Vital, have only one feeder main, entirely without support, extending for several miles within their boundaries. These municipalities require extensive improvements and will be compelled to build additional feeder lines if present plans for new housing developments become a reality.

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Special Water Districts in the Austin Metropolitan Area

—John Gillespie—

A contribution to the Journal by John Gillespie, Research Assoc., Inst. of Public Affairs, Univ. of Texas, Austin, Tex.

OBTAINING adequate water supplies for the rapidly increasing population in metropolitan fringe areas is a pressing problem. Usually the city is not anxious, and frequently not able, to extend its facilities beyond its boundaries. Existing demands placed upon the utilities by city residents often absorb the total output and on some occasions overburden the systems. New utility construction barely keeps ahead of increasing demand. If the city does not finance the construction of facilities for suburban dwellers, however, there is a possibility that the fringe area will incorporate itself as a separate city for the purpose of obtaining municipal services, especially water, and thus interfere with the master plan of the central city which may call for future annexation of the area. Even if the central city is able to annex adjacent incorporated areas, it will inherit public utilities that may not fit into the urban utility system. If mains are inadequate, replacement will be costly; if equipment is not standard, repairs may be expensive. The decision to service or not to service the fringe area is a difficult one for the city to make.

In the Austin, Tex., metropolitan area, the central city is not confronted with such a problem, for it is able to furnish water to the fringe area without the expense of adding to its existing water system. This is done through the expedient of special water districts, which the city encourages residents in the unincorporated places to organize. It has been the general policy of Austin to aid in the creation of water districts, and the city now refuses to extend service to individuals outside the corporate limits. It will sell only to special water districts.

Anyone who is interested in attempting to organize a water district will find Austin officials ready to offer not only suggestions but also such facilities as addressograph plates containing the names and addresses of residents in the area of the proposed district (who are customers of the Austin electric system), so that notice of preliminary meetings may be sent them. Often city officials will attend organizational meetings to explain the advantages of forming a water district.

Because Austin has the only adequate water supply in the area, it is able to dictate the terms under which it will supply water to the surrounding territory. According to Texas law, the special districts in the metropolitan area are independent governmental entities, but, in practice, they are completely subordinate to the city. Austin keeps the districts dependent by means of an intergovernmental contract under which the city agrees to furnish water to the district and to operate and maintain the water system, which is owned by the district.

There are now four water districts in the Austin metropolitan area. Factors contributing to the increase in the number of these districts have been the rising demands for water in recent years and the realization by property owners that the rapid growth of Austin has caused the land outside the corporate limits of the city to be shifted from agricultural to residential use. Inasmuch as subdivisions need a consistent and adequate water supply, property owners have formed these single-purpose districts in order to obtain it. They have been organized with the expectation that Austin will annex the territory of the district in the near future, and one of the aims of the district is to attract the overflow population and industrial growth of the city.

Austin wants to be certain that the water facilities in any territory that it intends to annex will fit into its system plan. The specifications for special-district water systems, therefore, are precisely set in a formal contract and are rigidly enforced by the city.

Under the terms of the contract, Austin agrees to sell water to the district, which must buy all its water from the city. The water purchased is measured by a master meter at the point of delivery, and the city agrees to maintain a constant pressure at that point. The furnishing of an adequate supply of water to the district is subject to prior demands of city residents and existing nonresident customers. The district may not sell water without city approval to anyone who does not reside in the district, nor may it sell water to anyone for resale. The city is not liable to the district or the latter's customers for failure to deliver water because of conditions beyond city control.

The rate charged to the special district is the same as for other outside-city customers—150 per cent of the rate for city residents. The district is obliged by the contract to charge its consumers uniform rates, which the district determines. The city renders a bill for water consumption once a month, and, if the district fails to pay within 20 days, Austin may terminate the contract.

The special district agrees to construct its own mains and water lines, but city specifications must be used. As previously mentioned, the specifications which Austin sets are determined by the consideration that the water system of the district will someday become an integral part of the Austin system. The district may not allow privately owned mains or water lines.

Austin requires existing city customers who live within the jurisdiction of a newly formed water district to become customers of the district. Thus, the city does not become a competitor of the district but aids it by turning over customers to it.

District bonds are callable 5 years from date of issue or on any interest-paying date thereafter. The city has the option, after 2 years from the date of the contract, to buy the system from the district for a price represented by the outstanding debt and interest thereon, less money on hand in the bond fund and all other cash assets of the district. Austin has already purchased the water systems of three districts. A 90-day notice of intention to purchase must be given. The contract is effective for 30 years and may be terminated by either party with a 90-day written notice.

The water system of a special district is operated as if it were part of the Austin system. The city agrees to operate and manage the special district's system in accordance with the current practices followed by the city

in the operation of its own water works. Austin takes over complete control and management of the system, including the reading of customers' meters. The contract allows the city to do "any and every other thing necessary or incident to the operation and management of an efficient water system, including the servicing of the district's outstanding bonds."

The district may enter into a refund contract with subdividers, to encourage extension and development of the new water system. The costs of the extension of mains in the subdivision are to be financed by the subdividers, and the refund contract must provide that, at the end of the fourth year following the extension, the district refunds to the subdividers half the total amount of the water bills of the customers served by the extension during the preceding year. The district continues payment for a period of 10 years or until the total cost of the extension has been refunded, whichever occurs first. The title to the extension is to be with the district. If Austin purchases the water system, the city agrees to assume all the refund obligations.

For its services, the city receives a fee of $0.50 per bill for reading meters, billing, and collecting from the district's customers. The charge is based on the Jul. 1, 1952, salary scale for city employees. Any change in the scale, up or down, is to be met by a proportional change in the charge.

An additional service charge of $0.35 per customer per bill at the end of the calendar year is made for accounting and adjustment. If actual costs are in excess of this charge, the district pays the excess. If costs are lower, the difference is returned to the district. The city also charges for each new connection that it makes in the special district. The charge is the city's actual cost, defined in the contract as the actual cost of materials and labor plus 10 per cent for administrative overhead. The city receives a $10 service deposit from each customer of the district. Whenever the city is owed money by the district, the city is permitted to deduct the amount due from the district's accounts in its possession.

The contract between the city and the special district is automatically terminated in the event of an incorporation of any new municipality embracing all or part of the special district. By this provision, Austin has been able to forestall the creation of satellite cities in most of the heavily populated areas on its boundaries. Four areas adjacent to the city, with sufficient population to become incorporated cities, are inextricably bound to Austin through their water mains.

By furnishing water and operating the local system, Austin relieves the special-district government of all administrative duties. Once the bonds have been sold and the system has been constructed, the city moves in and unifies water distribution. Although there are five local governmental units with a water system—the city and four districts—centralized operation under the city brings the economy of large-scale operation and the efficiency of unified control to all of them.

Through the use of special districts, residents in areas outside the city are able to get an adequate supply of water at a reasonable cost many years sooner than if they were to wait for Austin to grow and extend its system to them. In addition to its convenience, a constant water supply enhances the value of property in special districts and induces urban development. Water districts in the metropolitan area have benefited both the central city and the fringe area.

Formation of Southeastern Oakland County Water Authority

George G. Schmid

A paper presented on Sep. 16, 1954, at the Michigan Section Meeting, Muskegon, Mich., by George G. Schmid, Engr.-Mgr., Southeastern Oakland County Water Authority, Royal Oak, Mich.

As early as June 1948, in southeastern Oakland County, Mich., the communities foresaw the need for supplemental supplies of water. With their facilities just able to take care of existing needs and with increasing development in and around their borders, definite and positive action was indicated. The ever increasing per capita use of water further complicated matters. Even though water supply was given a high rating among necessary facilities to be provided and though the state apparently contains many suitable surface supplies, the communities lacked the means of financing the development of separate supplies at locations outside their boundaries. Several of the cities using wells explored unsuccessfully the possibility of increasing subsurface water supplies within their boundaries. It was something of a paradox that most of the communities were located in an urban fringe area with no immediate access to an adequate surface supply, while the increasing demand was due to the movement of people out of the adjacent large city, which bordered such a supply.

In a situation of this type, it is often advantageous for the fringe communities to develop their systems using the supply from the larger city as a base, particularly when water can be purchased and transmitted at reasonable cost under favorable conditions. Several of the communities were being wholly or partially supplied in this manner, but deficiencies in their own internal systems were preventing them from meeting peak demands.

The communities in south Oakland County had for some time been working together to solve many common problems, and the public and official support that is so vital to joint community enterprise was well established. In June 1949, after a year of very informal discussions, representatives of several of the communities held a series of meetings to discuss the water supply problem and to examine the corrective measures to be taken. There was early agreement that the delivery of water to the consumer at the lowest possible rates meant that duplication of transmission mains, reservoirs, and other facilities must be avoided. Furthermore, the water must not be priced beyond the reasonable ability of the consumer to pay. Finally the communities agreed to finance the activities of a committee composed of official representatives from each of them. The committee was requested to arrange for an engineering study of the feasibility of organizing an authority to pro-

vide for and operate a joint water supply system.

Preliminary Study

In January 1950, with the approval of the member communities, the committee engaged the services of a consulting engineer to make the study, which was to include possible sources of supply, present and future requirements, tentative layout of necessary facilities, estimates of construction and operation costs, financial proposals, and a suggested basis for the distribution of expenses among the member cities. The engineering report, submitted in September 1950, considered two alternative supplies—one from Lake Huron, costing $20,000,000, and the other from Detroit, costing $4,000,000.

The first source contemplated 1952 water rates of $4,06 per 1,000 cu ft and the second $1.55 per 1,000 cu ft. It was estimated that, by 1970, the rates would be more nearly alike—$1.24 for the Detroit supply and $0.87 for the Lake Huron supply. Increased costs of construction have since raised these figures, which were estimated in 1950.

Copies of the report were distributed to officials and other interested persons for review and recommendation. After several months the committee reported that the supply from Detroit was more readily obtainable and could be more easily financed than that from Lake Huron. Detroit had been kept informed of the progress of the committee's efforts and had agreed to supply the proposed authority with sufficient water, within reasonable limitations. The recommendations of the study committee were accepted by the interested participants, and the work of completing the many details of such an undertaking began in earnest. The first matter to be resolved was the formula for the distribution of costs. The engineering report had suggested the following scheme:

1. Half the debt requirements to be distributed annually among the several communities on the basis of the latest equalized valuations.

2. The other half of the debt requirements to be distributed annually on the basis of the ratio of the maximum daily demand of each community to the sum of the maximum daily demands of all.

3. The remaining costs—operation, maintenance, administration, electric power, and purchased water—to be charged on the basis of the quantity of water taken.

This formula was not acceptable to all of the cities, and many variations were discussed. Some of them considered factors such as: ratio of fire flow requirements; mixing of well water with system water; maximum demand with relation to storage capacities; maximum design capacity with relation to distance from source to average point of individual community takeoff; and ultimate capacity of system with relation to average daily use and maximum hourly use. Late in 1951 the following compromise was adopted:

1. Half the debt requirements to be distributed annually on the basis of the ratio of the estimated 1970 maximum daily demand of each community to the sum of the estimated 1970 maximum daily demands of all the communities (called the ready-to-serve charge). In the event of a future increase in the estimated 1970 demand of a given

community, its share of the charges will be increased proportionately and a lump-sum payment of retroactive charges will be required.

2. The other half of the debt requirements and the costs of operation, maintenance, administration, electric power, and purchased water to be charged on the basis of the quantity of water taken (called the rate charge).

In the application of the formula, each participant estimated a maximum daily demand to meet its requirements in 1970, and the system was designed to meet the total maximum daily demand. Every participant must pay the ready-to-serve charge annually, whether or not it has purchased any water from the system during the year. It is obvious that the more water purchased from the system by the participants, the lower the commodity charge becomes.

While the discussions with regard to the distribution of costs were in progress, the study committee was in consultation with experts on legal and financial matters. As existing state law was not entirely suitable or satisfactory, the committee sponsored an enabling act at the 1952 session of the legislature. Committee members were in daily attendance while the bill was in process, to answer any questions concerning it. The bill, with some amendments, was passed as Act 196 of the Michigan Public Acts of 1952. Taking advantage of its provisions, the cities of Berkley, Birmingham, Clawson, Huntington Woods, Pleasant Ridge, and Royal Oak and the township of Southfield decided to incorporate the Southeastern Oakland County Water Authority. The powers and functions of the authority are outlined below.

Authority Powers and Functions

The enabling act provides that any two or more cities, villages, or townships, or any combination thereof, may incorporate an authority for the purpose of acquiring, owning, and operating a water supply system or systems. The authority shall be composed of the territory lying within such municipalities. The authority can sue and be sued in any court of Michigan. It can acquire property for a water supply system by purchase, condemnation, lease, gift, or bequest, either within or without its corporate limits, and it may hold, manage, control, sell, exchange, or lease such property.

The authority and any of its constituent municipalities have the power to contract for the sale and purchase of water. The charges specified in such contracts are subject to increase by the authority at any time, if necessary in order to provide funds to meet its obligations. The authority may also contract for the sale and purchase of water with cities, villages, and townships which are not members of the authority. Charges for water to nonmembers may be greater than to members. Contracts may be for a period not exceeding 50 years. Any nonmember city, village, or township desiring to join the authority may be permitted to do so through amendment of the articles of incorporation by the legislative bodies of member municipalities.

The legislative body of each member municipality is authorized by the act to raise by tax, or pay from its general funds, the sums required by the articles of incorporation or by contract between it and the authority, unless some other method is provided therefor in the articles of incorpora-

tion or contract. The authority itself has no direct taxing power.

The authority may issue self-liquidating bonds, provided that no such bonds shall be a general obligation of the authority but shall be payable solely from the revenues of the water supply system.

Within the scope of the act, the authority has the right to determine what constitutes its water supply system and the functions thereof and may determine whether its water services shall be furnished to public corporations or private consumers or to both.

The governing body, known as the board of trustees, consists of representatives appointed by each constituent municipality for one year. The board members serve without compensation, but, at the discretion of the board, are paid for any actual expenditures they incur in connection with the business of the authority. At the organization meeting held at the beginning of each fiscal year, the board selects a chairman, vice-chairman, and secretary from its members, as well as a treasurer, who need not be a board member and who is bonded at the expense of the authority. The board also selects two members to act with the chairman as an operating committee to perform the purely administrative functions of the authority in harmony with the adopted policies of the board.

Each member of the board is entitled to one vote for every 250 mil gal (or major fraction thereof) of water delivered per year to his community, with each representative having at least one vote. The presence of members of the board holding more than 50 per cent of the total voting power of the entire board is required for a quorum. In ordinary business matters, the affirmative vote of members possessing more than one-half of the total voting power of the board is required. In matters concerning the changing of estimates of maximum daily demands of member municipalities, the fixing of authority compensation to personnel who may be employees or officers of constituent municipalities, or the refusal or neglect of a constituent municipality to enter into a contract for the purchase of water from the authority, affirmation by two-thirds of the total voting power of the board is required.

Facilities and Operation

The authority system will provide for estimated 1970 maximum-day needs of 42.1 mgd and maximum-hour needs of 84.4 mgd. A 10-mil gal steel reservoir, three 1.0-mil gal elevated tanks, two major pumping stations, and one standby station will be constructed, and a 1.5-mil gal elevated tank and a major pumping station will be purchased. The system will include 126,000 ft of new water mains, 16–36 in.; 12,350 ft of 48-in. steel mains and 3,350 ft of 16-in. mains, already laid, will be purchased. The total cost of the system is estimated at $6,000,000.

Water, purchased from Detroit at its suburban municipal rate of about $0.65 per 1,000 cu ft, will be resold to the participating communities at an average rate of about $1.35 per 1,000 cu ft. By 1970 the latter rate is expected to have dropped to an average of $1.25 per 1,000 cu ft. The participating communities will add their costs and will sell to their consumers at rates determined by them.

Communities with well supplies will be permitted to mix their water with authority water in their own mains.

The authority will conform to Detroit regulations governing the installation of water mains and appurtenances and the usage of water. In turn, the authority will require that the constituent municipalities follow the same standards and regulations. The authority will provide adequate inspection of all installations.

The contract between the authority and Detroit will extend to at least Jul. 1, 1985, and may be terminated by either party after that date upon 2 years' notice. If an authority or similar body should be created for the purpose of supplying water to the Detroit metropolitan area, and if Detroit should secure its supply from that source, the Oakland County authority will have the right to terminate the present contract and obtain its supply directly from the metropolitan area authority.

The Oakland County authority was officially organized on Feb. 17, 1953. It is expected to begin supplying water by the fall of 1955 and to be in full operation by the fall of 1956.

Fluoridation Endorsed in Canada

On the basis of a survey of preventive-medicine departments in North American universities, the Health League of Canada has voted to give full support to the principle of fluoridating communal water supplies. A resolution adopted by the board of directors of the league states that evidence amassed leads to the conclusion that fluoridation will prevent dental caries without having harmful effects, assuming that it is carried out as recommended by public health authorities.

The survey was made by a special committee of doctors and dentists, at the request of the Canadian Federation of Mayors and Municipalities. Letters were sent on May 6, 1953, to every university in North America having a preventive-medicine department, requesting opinions on the value of fluoridation in preventing dental caries and on the possibility of deleterious effects. Of the 71 university departments which replied, not one was opposed to fluoridation, and 63 endorsed the principle unreservedly. Six stated that they could not give opinions as they had not studied the subject, and one department head said that, although he did not oppose fluoridation of water supplies, he would prefer adding fluorides to foodstuffs.

* * *

The general council of the Canadian Medical Assn. has "endorsed without reservation" fluoridation of community water supplies under proper supervision and safeguards. The council adopted a report of the association's public health committee which declared that failure to approve fluoridation "would ignore the massive evidence of value and safety accumulated by use and study of this procedure in hundreds of cities on this continent during the past 8 years."

Industrial Use of Reclaimed Sewage Water at Amarillo

Marvin C. Nichols

A paper presented on Oct. 18, 1954, at the Southwest Section Meeting, El Paso, Tex., by Marvin C. Nichols, Freese & Nichols, Fort Worth, Tex.

THE prolonged drought in the Southwest has emphasized the importance of water to municipalities, agriculture, and industry. In many underground supplies, the rate of withdrawal is exceeding the rate of recharge. Small upstream flood detention reservoirs for the protection of creek valleys dissipate water in some degree. Moreover, the great population and industrial growth experienced by the area during the last decade has necessarily been accompanied by ever increasing demands for water.

It was with such a background that a program for the reclamation and use of sewage water at an oil refinery was developed by Amarillo, Tex., and the Texas Co. Most of the credit goes to such Texas Co. officials as Sam W. Johnson, Plant Superintendent, and O'Brien Thompson, Plant Chemist, who considered the project a sound water conservation measure, as well as a sound business undertaking for their company.

Bonds in the amount of $720,000 were voted by Amarillo in December 1951 for improvements to the sewage treatment plant. Constructed in 1928, this 2–3-mgd plant was designed for primary clarification, modified aeration, and final clarification, but it has usually been operated without aeration. The effluent discharges into East Amarillo Creek, a tributary of the Canadian River. A limited use is made of the effluent for irrigation. The effluent reaching the creek is used for sand and gravel washing operations and for stock watering. Although the plant is greatly overloaded, no serious complaints have been made concerning its operation. The plant is located about 10 miles north of Amarillo.

At the time of the bond election the average sewage flow was 6 mgd. The original intention was to construct, in stages, a high-rate filter plant with separate sludge digestion. Initially, only primary clarification and sludge digestion facilities were to be built. Owing to the location of the plant, it was not then believed necessary to provide complete treatment.

While these plans were maturing, officials of the Texas Co. expressed an interest in the possibility of using reclaimed sewage water in the operation of the Amarillo refinery, which has been in existence for many years. In the summer of 1952 the company had announced plans for a $20,000,000 expansion of the refinery. The expanded plant would require considerably more water than is now being furnished it by the city and several small company-owned wells. The officials of the com-

pany believed that: [1] the reclaimed sewage water could be used for at least some refinery purposes; [2] the cost would probably be comparable to that of fresh water; [3] it would be an absolutely dependable source of supply; and [4] the project would be a water conservation measure. City officials shared these views, and negotiations were begun early in the fall of 1952. The final terms of the 30-year contract were agreed upon in late 1953.

Contract Terms

Neither party had had experience with the use of reclaimed sewage water for oil refinery purposes.* In the initial stages of the negotiations, the company could not say definitely what its quality or quantity requirements would be. Likewise the city could not precisely define the quality of the reclaimed water or specify the cost. Each party made studies of its respective problems, numerous conferences were held, and several drafts of the contract were prepared. The contract as finally agreed upon is flexible as to the quantity to be taken by the company, with provision for an annual review of the cost of furnishing the reclaimed water.

The city voted and issued additional bonds to cover the cost of complete treatment, as well as for the reclaimed-water line and pump station. The contract provides for minimum payments by the company sufficient to amortize fully the cost of the facilities allocated for its use. It is the intent of the contract that reclaimed water be furnished the company at cost. Essentially, the company assumes the risk that the water will be suitable for its purposes. If the project proves successful, the city will have effected a substantial water conservation program. If additional customers for reclaimed water are obtained, a profit on the overall operation will be made by Amarillo.

The final contract called for the city to furnish 1.5 mgd of reclaimed sewage water, with the company having a first option up to a total of 4.5 mgd. Lagoon storage of a 3-day supply was provided for. The water was to have the following characteristics: pH, 6.8–9.0; suspended solids, 25 ppm maximum; BOD, 25 ppm maximum; free chlorine residual, 0.1 ppm, with the company having the option to reduce this requirement to not less than an amount sufficient to prevent formation of slime or algae in the reclaimed-water line.

Cost Estimates

During the negotiations it was decided to abandon the initial plan of treatment by high-rate filters and to build an activated-sludge plant with an initial capacity of 4.5 mgd, laid out so as to be easily expandable to a capacity of 9 mgd. A 10-mile pipeline with a capacity of 4.5 mgd is required, together with a pumping station. The new plant is being built at the site of the old one.

* Although without direct experience in this field, the city did have the benefit of a similar project at Big Spring, Tex., where the Cosden Petroleum Corp. refinery uses about 1 mgd of reclaimed sewage water from the municipal activated-sludge sewage treatment plant. The water is delivered to the Cosden Corp. in a small lagoon at the sewage plant. The company, which owns and operates the pipeline from the lagoon to the refinery, pays the city approximately 5 cents per 1,000 gal at the lagoon. A description of the Big Spring sewage plant, together with information on sales of reclaimed sewage water, is given in a 1949 article by H. W. Whitney (*1*).

The company agreed to pay a minimum monthly charge of $4,367.90 to cover amortization and interest (30-year, 3½ per cent bonds) on $964,000, of which $450,000 represented the estimated additional cost of providing reclaimed sewage water to meet company criteria, and $514,000 the cost of the reclaimed-water line and pumping facilities. For the first year, the company agreed to pay, in addition, 3.75 cents per 1,000 gal of reclaimed sewage water delivered to it. This figure, the estimated operating cost, includes an allowance of 1 cent per 1,000 gal for chlorine. The amount of chlorine thus

TABLE 1

Cost of Reclaimed Sewage Water

Quantity *mgd*	Reclaimed-Water Cost *¢/1,000 gal*			City Water Rate *¢/1,000 gal*
	Amortization	Operation*	Total	
1.5	9.57	3.75	13.32	13.67
2.0	7.18	3.75	10.93	13.63
3.0	4.79	3.75	8.54	13.58
4.5	3.19	3.75	6.94	13.56

* Includes 1 cent per 1,000 gal for chlorine.

provided will be insufficient to give a 0.1-ppm free chlorine residual. If the company finds that such a residual must be maintained—a doubtful assumption—the cost of additional chlorine will add 6–7 cents per 1,000 gal to the operating cost. (This estimate is based upon oxidation of ammonia by chlorine, but it is believed likely that other methods will be found more economical.) At the end of each year the operating costs will be audited and payments adjusted on the basis of actual cost.

Taking these estimates and the contract terms into account, Table 1 gives the approximate cost of various quantities of reclaimed sewage water delivered to the refinery. The last column shows the present city water rates, which will probably be increased at some future date.

It should be pointed out that the treatment of the reclaimed water for some purposes by the company will be more expensive than that required for fresh water. The reclaimed water will be higher in dissolved solids, sulfates, chlorides, and ammonia than fresh water. The relative economics of the refinery operation will determine the amount of reclaimed water used, the purposes it will serve, and the number of times it will be reused before being sent to the waste water evaporation ponds.

Lagoon Storage

Based on a series of analyses made in 1952 at the present Amarillo sewage plant, Table 2 compares the chemical content of fresh tap water (from wells) with that of the effluent from the sewage plant. A similar comparison, for San Antonio, Tex., based on data furnished through the courtesy of W. N. Wells, the sewage plant superintendent there, is also shown. It will be noted that the increases in chemical content are of the same order for both effluents, although somewhat lower at San Antonio. It was learned, incidentally, that about 10 ppm of chlorine is required to oxidize 1 ppm of ammonia.

The chemical content of the raw sewage varies quite markedly over a weekly cycle and to a smaller degree on a 24-hr cycle. This fact emphasized the desirability of some lagoon storage at the treatment plant to insure the delivery of reclaimed water with a rea-

sonably uniform chemical content. A gradual change in chemical content would not be too serious at the refinery, but sudden changes would make operation difficult. Lagoon storage is also required when the delivery of reclaimed water approaches the minimum hourly sewage flow, and storage will provide insurance against breakdowns. The company expects the delivery of reclaimed water to be made at a reasonably uniform rate throughout a 24-hr period.

fiers, equipped with mechanically operated sludge removal equipment; separate sludge digestion tanks, having floating covers, with provision for heating by the use of sewage gas; sludge-drying beds; administration, laboratory, air blower, and sludge-pumping buildings; a 9-mil gal lagoon for final effluent; and chlorinating equipment. All sewage is handled by gravity. The 10-mile, 4.5-mgd reclaimed-water line is an 18-in. steel cylinder concrete pipe.

TABLE 2

Increases in Chemical Content

Constituent	Amarillo			San Antonio		
	Tap Water *ppm*	Sewage Plant Effluent *ppm*	Increase *ppm*	Tap Water *ppm*	Sewage Plant Effluent *ppm*	Increase *ppm*
Dissolved solids	368	743	375	255	538	283
Chlorides	7	115	108	12	105	93
Sulfates	35	81	46	13	47	34
Silica	65	75	10	11	20	9
Ammonia		14			6	

Treatment Plant Details

Owing to the fact that the new sewage treatment plant is designed for an ultimate capacity of 9 mgd, some units now being constructed have a capacity greater than the initial minimum of 4.5 mgd. It is considered probable that the plant will deliver a satisfactory effluent at a 6-mgd rate. The essential elements of the plant include: a screen channel with mechanical rake; a grit channel with mechanical grit removal equipment; a Parshall flume; a circular primary clarifier, equipped with mechanically operated sludge and scum removal equipment; pre-aeration basins; aeration basins, equipped with swing air diffusers; circular final clari-

Because of the importance of the chlorine requirement, provision was made for chlorination at four points: [1] in the raw sewage, as it enters the plant; [2] in the return sludge, prior to mixing with the effluent from the primary clarifier; [3] in the aerated sewage, as it leaves the aeration basins; and [4] in the treated effluent from the lagoons on the suction side of the reclaimed-water high-service pumps. Chlorine control at the respective points will be carried out: [1] by a Parshall flume or oxidation-reduction potential cell; [2] by an oxidation-reduction potential cell; [3] manually, with a potential cell for sampling the aeration tank effluent to determine the

degree of treatment accomplished; and [4] by a residual recorder-controller measuring the chlorine residual in the treated effluent. As an indication of the importance attached to the chlorine treatment, it may be noted that the cost of these facilities is about $35,000.

The completed sewage plant will cost approximately $860,000. The reclaimed-water line, together with the pumping station, is now estimated to cost $360,000. The original estimate for the plant was $900,000, and, for the water line facilities, $514,000.

Conclusion

The use of reclaimed sewage water by industry has definite possibilities in the Southwest as a means of water conservation. The costs can be expected to compare favorably with those of other sources of supply, and reclaimed water is a more dependable source of supply than are many others. At Amarillo, the use of reclaimed water was not made necessary by a shortage of fresh water. The city has a supply adequate to meet all reasonable requirements, and the Texas Co. can buy fresh water at a satisfactory rate to meet its needs. As a good citizen, however, the company elected to undertake this water conservation measure in the belief that it would also prove a sound business investment. Amarillo, through its voters and officials, met the company at least halfway. Without such an attitude on the part of both parties, the project would not have been accomplished. Although only operating experience can demonstrate the wisdom of this cooperative undertaking, it is believed that the project will prove to be sound.

Reference

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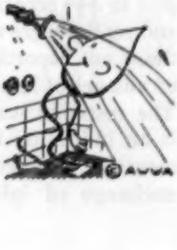

Michigan Water Works Operating Data for 1953

Claud R. Erickson

A paper presented on Sep. 17, 1954, at the Michigan Section Meeting, Muskegon, Mich., by Claud R. Erickson, Mech. Engr., Board of Water & Elec. Light Comrs., Lansing, Mich.

THERE are more than 400 separate water departments or authorities in Michigan, obtaining water from wells or surface sources or by purchase from other utilities. These water works serve villages, cities, or districts with populations varying from less than 1,000 to more than 2,000,000. The operating conditions and the physical plants of these utilities differ with the needs of the area served. Some have industries that require a large percentage of the total water pumped, while others have relatively little, if any, industrial usage.

A survey by the Michigan health department shows that 80 per cent of the state's population receives water from central pumping plants. Based on this percentage, it is estimated that 5,120,000 people—equivalent to 1,280,000 family units—rely on some utility for their water requirements. The remaining family units, approximately 320,000, have private wells and pumps.

Questionnaires requesting data on operating and physical statistics were sent to 344 separate water departments, and replies were received from 123. Of those not reporting, 200 were in cities or villages of less than 7,000 population. The response was most gratifying and is an indication that the water departments of Michigan are interested in an exchange of information and have a desire to learn more about the water supply problems of other communities.

The data obtained indicate that the people of Michigan have an investment of approximately $575,000,000 in both public and private water supplies. Of this amount, $450,000,000 is invested in public water supplies under the jurisdiction of water departments or commissions. A statistical summary, by population groups, is given in Table 1.

Per Capita Use

The pumpage, in terms of gallons per day per capita, varied from a low of 13 to a high of 690, with a weighted average of 163. Table 2 shows the distribution of per capita pumpage. The communities with relatively low per capita pumpage were predominantly residential, having very little industrial use, while those with a pumpage exceeding 200 gpcd were either predominantly industrial or had some large industry that required great amounts of water.

During the past 35 years the per capita use of water has doubled and it can be expected to increase in the future, owing to greater utilization of air-conditioning equipment, garbage disposal units, automatic dishwashing and laundering units, shower baths, and industrial processes employing water. The trend of the per capita use of water in

any community over a period of years is an excellent index of future water requirements.

Accounted-for Water

A summary of data on accounted-for water (the ratio of the amount sold and

TABLE 1

Summary of Michigan Water Works Operating Data, 1953

Item	Population Group					
	60,000 +	20,000–60,000	11,000–20,000	7,000–11,000	2,000–7,000	2,000 –
Cities queried	10	16	24	16	99	179
Cities reporting*	9	13	12	9	32	48
Avg population	103,670	32,147	16,150	9,289	4,142	1,068
Avg pumpage—*gpcd*	161	155	190	174	144	154
Accounted-for water—*per cent*	87.4	98.0	97.4	81.2	86.2	88.9
Avg no. of customers	27,593	6,704	4,256	2,841	1,377	368
Meters per customer	1.01	0.998	0.969	0.74	0.92	0.74
Population per meter	4.02	4.45	3.92	4.51	5.12	3.93
Ratio of max. to avg daily pumpage	1.73:1	1.68:1	1.78:1	2.25:1	2.01:1	1.92:1
Ratio of available capacity to max. daily pumpage	1.47:1	1.91:1	1.43:1	1.37:1	1.69:1	1.50:1
Ratio of reservoir capacity to avg daily pumpage	0.82:1	0.31:1	0.48:1	0.54:1	0.53:1	0.68:1
High-lift pumping—*mgd*						
Steam	67.2	18	0	0	0	0.6
Electric	32.3	17.8	7.72	7.36	2.59	0.97
Diesel or gasoline	0	0	1.96	1.44	0.89	1.63
Avg HLP† capacity—*mgd*	47.5	20.4	8.81	7.57	2.70	1.23
Ratio of HLP† capacity to max. hourly pumpage	1.51:1	1.46:1	1.20:1	1.37:1	1.28:1	1.61:1
Avg pressure at pumping station—*psi*	64.4	55.9	71.0	70.6	70.4	58.7
Avg pressure at system extremity—*psi*	19.1	35.2	33.7	41.6	37.0	38.3
Avg miles of distribution mains	265	74.6	49.3	31.4	19.7	6.33
Avg miles of transmission mains	18.1	3.74	23.4	0.57	0.94	1.62
Avg miles of services	334.5	57.2	27.5	17.7	12.8	4.10
Population per hydrant	53.4	53.0	45.2	37.4	33.4	26.0
Hydrants per mile of main	7.32	8.6	8.86	7.09	6.65	6.32
Valves per mile of main	11.94	14.22	11.80	11.46	11.62	8.22
Water services						
City installs	6‡	9‡	8‡	7‡	18‡	37‡
Owner pays	9‡	13‡	12‡	7‡	18‡	23‡
City maintains	7‡	8‡	4‡	6‡	20‡	36‡
Avg total investment—$	8,148,858.80	2,138,282.36	1,679,352.70	548,425.69	404,016.30	126,218.30
Avg annual revenue—$	978,882.51	255,385.60	187,195.96	82,682.60	34,281.41	10,439.53
Ratio of investment to annual revenue	8.32:1	8.68:1	8.97:1	7.63:1	10.61:1	11.88:1
Revenue—*¢/1,000 gal*	16.72	14.79	15.32	14.56	14.47	18.31
Sewerage charge						
Included on water bill	5‡	9‡	7‡	7‡	11‡	8‡
Per cent of water bill	49.0	50.6	65.3	51.2	66.2	50.7
Pension plan	9‡	11‡	12‡	8‡	8‡	1‡
Avg no. of employees	81.3	15.6	13.8	7.4	3.9	1.84
Avg no. of employees under civil service	63.3	13.1	4	0	0	0.07
Population per employee	1,500	1,920	1,270	1,120	1,100	640
Per cent of population using water treated in following ways:						
Lime-soda ash	44.6	0	34.1	0	0	14.4
Cation exchange	0	6.8	0	13.2	3.3	0
Filtration only	30.3	19.2	29.2	25.7	20.5	14.5
Iron removal	0	4.8	5.7	13.2	9.3	10.1
Stabilizer	10.7	15.6	15.0	0	8.5	13.5
Chlorine	100	87.8	82.7	89.8	56.0	35.7
Chlorine dioxide	0	19.2	9.3	0	0	7.5
Other disinfectant	0	10.4	0	8.7	0	0.7
Other treatment	31.0	18.9	34.7	23.9	19.2	7.3

* All data are for cities reporting.
† High-lift pumping.
‡ Number of cities.

used to the amount pumped into the system) is given in Table 3. A surprising number of water works reported 100 per cent utilization, which indicates that the distribution system has no losses of any nature. It was equally surprising to note the excellent condition of practically all the systems; only 16 had more than 15 per cent unaccounted-for water. But 49 of the communities reporting apparently keep no record of this important ratio.

TABLE 3

Accounted-for Water

Pumpage Accounted for *per cent*	No. of Communities
under 75	6
75–79	6
80–84	4
85–89	7
90–94	8
95–99	6
100	34

Number of Meters

Statistics on the ratio of the number of meters to the number of customers are given in Table 1. It appears that, for communities serving less than 11,000, metering does not approach 100 per cent. Based on present meter prices, the value of all meters installed by Michigan water utilities is about $30,000,000. Assuming an average meter life and taking new customers into consideration, it is estimated that $2,000,000 worth of water meters are being purchased annually in Michigan. The average number of persons (not customers) per meter is four.

TABLE 2

Average Daily Pumpage per Capita

Pumpage *gpcd*	No. of Communities
under 50	6
50– 99	32
100–149	27
150–199	26
200 or more	16

Pumpage and Capacity

The ratio of the maximum daily pumpage during the year to the average daily pumpage (Table 4) varies from nearly 1:1 to 5.1:1, with an average of 1.75:1. The ratio of existing capacity to maximum daily pumpage, an indication of how much spare capacity is available before additional capacity will be needed, is shown in Table 5. Almost all communities are making adequate provision to keep production capacity in line with water demands. Communities with capacity-pumpage ratios close to 1:1 must draw on storage during periods of high demand. Thus, the ratio of total reservoir capacity to average daily pumpage (Table 1) is another significant item.

Disinfection

Every community with a population of more than 60,000 reported the use of chlorine, alone or in combination with some other chemical, to disinfect its supply. It is noteworthy that, in the smaller population groups, the percentage of consumers receiving water so treated decreased considerably (see Table 1).

TABLE 4

Ratio of Maximum to Average Daily Pumpage

Max. Pumpage / Avg Pumpage	No. of Communities
1.3–1.5	14
1.5–1.7	10
1.7–1.9	15
1.9–2.1	11
2.1–2.3	6
over 2.3	19

TABLE 5

Ratio of Available Pumping Capacity to Maximum Daily Pumpage

Available Capac. / Max. Pumpage	No. of Communities
under 1	2
1.00–1.24	19
1.25–1.49	11
1.50–1.74	10
1.75–1.99	11
2.00 or more	16

Pressures

The pressure maintained at the pumping station varies from a low of 35 psi to a high of 140 psi. The most prevalent pressure is between 50 and 60 psi. Table 6 indicates the range in various communities.

Mains and Services

As shown by the data in Table 1, there is an inverse relationship between per capita distribution main mileage and population served—that is, the smaller the community, the more miles of mains per thousand population. Based on a weighted average of 2.84 miles of main per thousand population, it is estimated that there is now nearly 15,000 miles of main in Michigan.

There were insufficient data to draw any definite conclusions on the relation of service line and main mileage. From the scattered data submitted, however, it would appear that service line mileage is 50 per cent of main mileage.

TABLE 6

Pumping Station Pressures

Pressure *psi*	No. of Communities
30–39	3
40–49	16
50–59	35
60–69	22
70–79	14
80 or more	22

Hydrants and Valves

The average population per hydrant is 48, the figure being greater in the larger communities (Table 1). The data obtained indicate that about 107,000 hydrants are installed in the various water systems throughout Michigan.

The number of valves per mile of main is fairly uniform. Most systems will average one valve per 440 ft of main. It is estimated that all water distribution systems in Michigan have installed a total of 175,000 valves of various sizes.

TABLE 7

Ratio of Investment to Annual Revenue

Type of Business	Investment / Annual Revenue
Retail store	
Groceries	0.05
Liquor	0.10
Appliances	0.14
Dry goods	0.20
Manufacturing	0.60
Motel	2.50
Electric generating system	4.50
Water supply system	9.00

Installation of Services

Of 123 communities reporting, 70 per cent install service lines with their own forces. The customer pays for this installation in all cities with more than 11,000 population. Of the smaller cities and villages, 54 per cent charge the customer for the service connection. After installation the service line is maintained by the utility in 66 per cent of the communities.

Sewerage Charges

A total of 47 communities stated that the cost of operation of the sewage disposal plant is included on the water bill. This charge, approximately 50 per cent of that for water, is sometimes based on the number of gallons used, or it may be

a flat rate per quarter, but the most popular method seems to be the application of a percentage to the water bill.

Utility Employees

There is, on the average, one water works employee per 1,440 population, the ratio of employees to population being generally greater in the smaller communities (Table 1). It is estimated that water works employees in Michigan total 4,000.

Out of 43 communities with more than 7,000 population, 40 report that some form of pension plan is in effect. This is an excellent coverage, equivalent to 93 per cent. Employees in smaller communities do not fare so well; only 25 per cent of the communities with populations of 2,000–7,000 have provided a pension plan for their water works personnel, while only two of 48 communities with less than 2,000 make such provisions.

In all the communities with less than 11,000 population, there are only three water works employees under civil service. In the group serving 11,000–20,000 population, 29 per cent of these employees are under civil service. In the 20,000–60,000 population group, the percentage is 84, and in the largest population group it is 78.

Revenue

The average revenue per 1,000 gal pumped into the distribution system is fairly uniform, regardless of population (Table 1). The weighted average for the 123 communities is 16.0 cents per 1,000 gal. The total amount of water pumped annually by all Michigan water utilities is estimated at 310 bil gal and the total revenue at $50,000,000.

Investment

One of the most interesting items revealed by this study was the number of dollars required to produce a dollar of revenue annually. As would be expected, the smaller the system, the greater the investment required. The weighted average for all systems is $9. Looked at in another way, this figure also represents the number of years needed to turn over the capital invested. When a comparison is made with the situation in other businesses (Table 7), it becomes evident that great care should be exercised in planning additions to water works systems because of the relatively very slow turnover.

A review of the returned questionnaires indicated that many of the smaller water systems had no data on the amount of money invested. In the light of the preceding facts, it would appear desirable for these systems to make a property record and appraisal of value, so that a proper amount of depreciation could be taken as an element of operating cost. The annual financial statement should then accurately reflect the status of the utility.

Selection of High-Lift Pump Motors and Controls

A. C. Michael and G. I. Stormont

A paper presented on Sep. 15, 1954, at the Michigan Section Meeting, Muskegon, Mich., by A. C. Michael, Supt. of Eng., and G. I. Stormont, Elec. Engr. of Design; both from Dept. of Water Supply, Detroit.

CHOOSING the proper motors and controls for a pumping application is a complicated and involved problem that can seldom be solved by any single individual, because many special skills are required for a complete solution. It is the intent of this paper to review generally some of the principal considerations in the selection of motors and controls for centrifugal type water works pumps, with specific reference to the design of the new Northeast Station of the Detroit Dept. of Water Supply.

The Northeast Station, which is now under construction and is scheduled to go into partial operation in 1955, is located on a 64-acre site. It will include a low-lift pumping plant, a chemical building, settling basins, a filtration plant with under-filter storage, separate filtered-water reservoirs, and a laboratory and administration building. The station, which will have an average capacity of approximately 100 mgd and a maximum capacity of 200 mgd, will operate on purchased power. Raw water will be supplied from the Detroit River to the plant by means of a 10-ft ID gravity tunnel, already completed, which branches from the tunnel supplying the existing Springwells Station.

The low-lift pumping plant is being constructed in a circular caisson, with the vertical pumps and motors in a dry well below grade (Fig. 1). There are six main pumping units, three rated at 50 mgd at 80-ft total head and the other three rated at 60 mgd at 80-ft total head. There are also two dewatering pumps rated at 7.5 mgd at 80-ft head. The main pumping units are driven by 900-hp and 1,250-hp synchronous motors, and dewatering units are driven by 200-hp squirrel-cage induction motors. It was not considered necessary to provide variable-speed drives for any of the main pumps, as close control of output is not essential and experience at the Springwells plant has shown that the two main units, equipped with slip ring drives, are seldom operated at reduced speeds. It is believed that use of the dewatering pumps for regular service will satisfactorily fill in any wide gaps left in plant delivery by the operation of various combinations of main pumps.

Selection of Pumps and Drives

Until recent years it was traditional to use horizontal double-suction pumping units for high-service water works applications. There are many such units in service and their record has been excellent. The horizontal unit, however, requires considerable floor space, which has necessitated larger pumping plant structures. In many such plants, attempts have been made

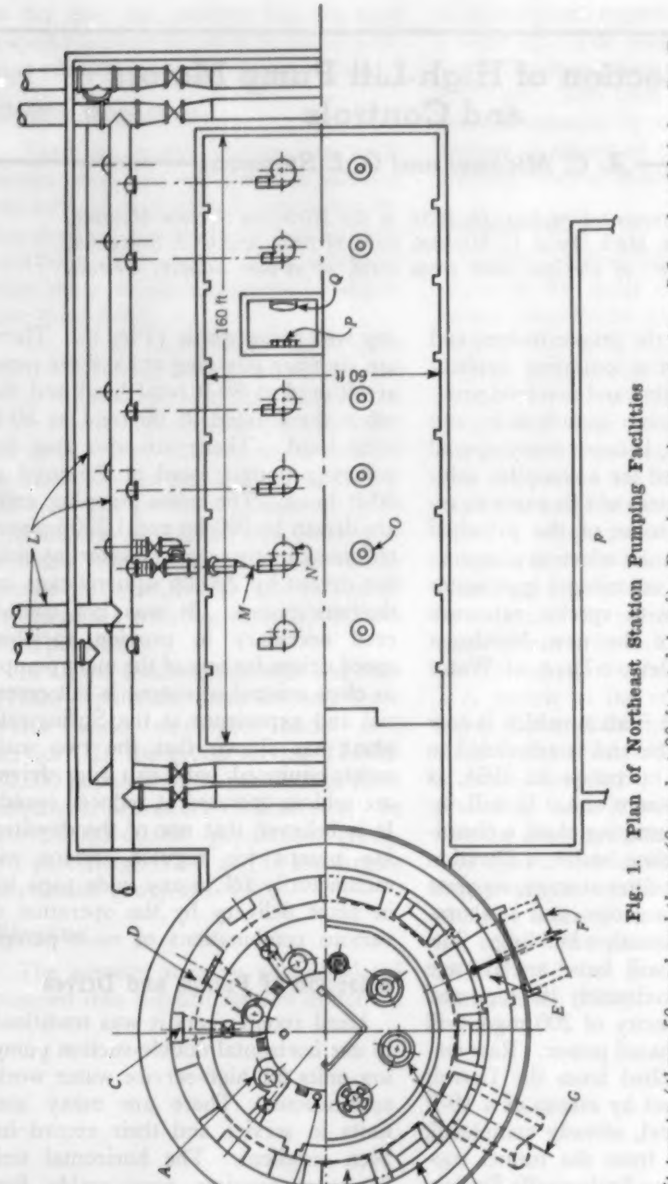

Fig. 1. Plan of Northeast Station Pumping Facilities

A—*low-lift pumps* (*three 50 mgd and three 60 mgd at 80-ft total head*); B—*dewatering pumps* (*two 7.5 mgd at 80-ft head*); C—*pump discharge flume*; D—*surge flume*; E—*annular collecting channel*; F—*raw-water conduit*; G—*10-ft ID raw-water tunnel centerline* (*approximately 107 ft below grade*); H—*low-lift pump motors*; J—*discharge weir* (*el 159.5*); K—*surge weir* (*el 163*); L—*54-in. headers*; M—*cone valve*; N—*high-lift pumps*; O—*high-lift pump motors*; P—*72-in. sluice gate*; Q—*72-in. flap valve*; R—*switch house*. *Initially the high-lift plant will be equipped with ten units* (*seven 40 mgd and three 30 mgd at 175 total head*). *Two of the larger units will be driven at variable speed by wound-rotor motors.*

to reduce the occupied floor space by setting the shafts of the pumping units at an angle to the axis of the building. This tends to complicate the piping arrangement.

It is desirable that water works structures, which are usually designed and constructed to endure for 50 years or more, be of spacious proportions for esthetic and other reasons. In these days of high construction costs, however, every consideration must be given to economy of design. In the study to determine the type of pumping units to be used at the Northeast Station, it was found very early that impressive savings in floor space would be realized if vertical units could satisfactorily be substituted for the horizontal double-suction type.

A comparison of the two types of units indicates that their efficiencies are approximately the same, that the operation and maintenance of either type present no unusual problems, that costs of the vertical unit are only slightly higher than those of the horizontal, and that the vertical type of pump unit has the important advantage of permitting mounting to minimize priming problems and to eliminate the danger of flooding the motor. It appears that the cost of vertical units, which are of simpler construction than the horizontal type, may be reduced when manufacturers have developed designs and patterns to meet the range of the various head and capacity requirements. Investigation showed that, in the Northeast Station, the floor space for vertical pumps could be approximately 50 per cent of that required by horizontal units. Consequently, it was decided to use vertical pumps in the high-lift plant.

Selection of the proper operating voltage can be a very important consideration. The Springwells plant, which operates at 4,600 v, was placed in service in the early 1930's and has suffered an excessive number of motor failures since 1940. Although the cause of these failures has not been definitely determined, it is believed that insulation and voltage factors have played an important part. No insulation failures have been experienced in the 2,300-v motors that have been in service at the Water Works Park Station since 1927. It was therefore decided to use the lower voltage at the Northeast Station. Moreover, it was found that the lower voltage permitted the use of less expensive switchgear and that the motor leads, being relatively short, were not required to be unusually large to avoid excessive voltage drop.

Pumps may be driven by many types of prime movers, including steam engines, steam turbines, diesel engines, gasoline engines, and electric motors, the last being the most common type of drive in use today. Electric motors may be of various kinds, depending upon the requirements of the application and on whether or not it is necessary to vary or control the speed of the pump. The delivery of water to the distribution system may be controlled by the motors themselves or by devices external to the motor, such as hydraulic or magnetic couplings or throttling valves in the discharge lines from the pumps.

Analysis of Demand

Before the drives for high-lift pumps can be selected, a complete study of the probable demand on the station must be made, in order to establish the size and number of pumps required. This study will include data for estimating the probable maximum demand and

the friction curve for the system to be served.

Figure 2 illustrates a typical load-duration curve taken from the records of the operation of the Springwells Station. This curve indicates the percentage of time during which the output of the station equals or exceeds the value shown by the curve. The shape of the curve is dependent upon many factors, such as weather, type of consumption, or existence of elevated storage. High demands are usually of short duration, as shown by the left portion of the curve.

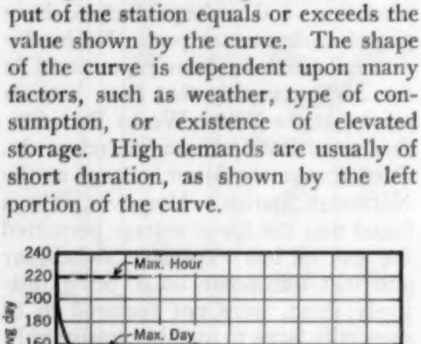

Fig 2. Typical Load-Duration Curve

The curve indicates the percentage of time any given load is equaled or exceeded.

The average per capita water consumption of the community served is subject to considerable variation. Care and judgment must be exercised in determining from all available data, including population trends and the type of community served, the average daily demand of the system to be supplied. The maximum-day demand determines the size of the low-lift pumping and water treatment facilities. The maximum-hour demand determines the size of the high-lift pumping and reservoir facilities.

A significant figure in determining the requirements for high-lift pumps is the ratio of the maximum-hour rate to the average-day rate. This figure is subject to considerable variation, and conservative design necessitates the use of the maximum ratio that can be expected. For the Northeast Station, a value of 2.70:1 was used to estimate the maximum-hour demand. The total

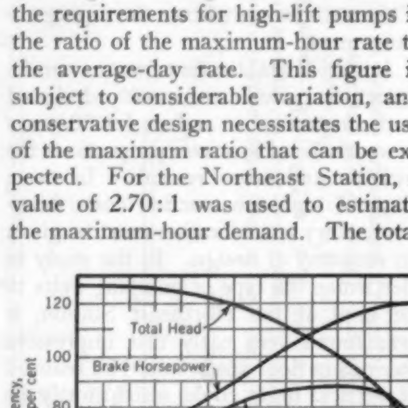

Fig. 3. Typical Pump Performance Curves

Total head is plotted as percentage of rated head; efficiency is typical for the kind of pumps selected for the Northeast Station; brake horsepower is computed from the total-head and efficiency curves.

installed capacity of the high-lift pumps at rated load should be approximately 125 per cent of this estimate, plus one additional pump of the largest size selected.

Increased flexibility and economy of operation can be realized by using pumps of different sizes in a single station. This permits the operation of pumps to meet demand with minimum throttling of discharge valves or reduc-

tion of speed. A convenient rule of thumb to follow in determining the relative sizes of pumps is to select a smaller pump two-thirds the size of the next larger pump.

The choice of motors and control equipment depends upon the characteristics of the pump to be driven. Data applicable to a pump of approximately the average size to be used in a station may be selected for design purposes, and the characteristics of this pump plotted as percentages of the rated values (Fig. 3). The resulting curves may be used to predict the performance of one or more pumps of any head or capacity rating, provided that they are homologous with the pump represented by the data.

A head-capacity curve with a relatively steep slope, like that in Fig. 3, is advantageous when two or more pumps are discharging into the same header, because a change in system pressure will result in a change in the output of each of the pumps approximately proportional to their ratings. If the characteristic curve is flat, there may be a tendency for one or more of the pumps to assume a disproportionate share of the load. Moreover, pumps with steep head-capacity curves can be used to advantage over a wider range of system pressures. This is particularly desirable where the transmission mains extend a considerable distance from the station. With a low system demand and a correspondingly low velocity in the mains, the friction losses to the fringe areas will be low. The pressures in the fringe areas under this condition will, therefore, be only slightly lower than the station pressure, which need not be high to provide adequate service. On the other hand, if the system demand is high, the station pressure must be increased by the amount of the system friction to maintain satisfactory pressures in the fringe areas. The station pumps under this condition will be required to operate at relatively high pressure, and this can be done satisfactorily only if the characteristic curve has sufficient slope. It is considered essential that the shutoff head be not less than 125 per cent of the rated head to insure a characteristic curve of adequate slope.

Some pumps are so designed that the head-capacity curve drops sharply at low heads. This may occur if the casing is too small for the impeller. Such a characteristic is undesirable, especially when the drop occurs at or near the minimum operating head.

A station designed to serve a new and expanding area may be required to operate initially at low heads for a considerable period. If the station pressure is expected to increase with time, it may be wise, at first, to equip the pumps with impellers rated at a low head, with provision for impellers of larger diameter to be installed at a later date. The motors driving the pumps should then be of sufficient size to operate the pumps with the larger impellers without being overloaded.

Pump Controls

Pumps may be started, stopped, and controlled by either manually or automatically operated devices. For a small station serving a system with relatively large elevated-tank capacity, fully automatic control of the pumps may be relatively inexpensive and dependable. On the other hand, a large station requires careful operation of the pumps to maintain continuity of service and uniform pressures. Automatic control equipment for performing criti-

cal functions is expensive and demands highly skilled maintenance men to keep it operating properly. Also, there is a possibility that automatic control equipment will respond in the wrong way to unforeseen conditions. Manual supervisory control should therefore be provided for all critical automatically controlled functions.

In large stations, operators must always be ready to deal with any unusual conditions that may arise. If the equipment is automatically controlled, the personnel will not be required to perform operations on a routine schedule. In such situations, it has been found that, when unusual conditions do occur, the men are not prepared by habit to carry out the required operations correctly. Hence, it is desirable to limit automatic controls to those operations which must be performed faster than can be accomplished manually and to simple operations that cannot be done manually with sufficient accuracy.

The output of pumps may be regulated by starting and stopping them on schedule so that the average output conforms with the demand, by controlling the pumps so that the output continuously conforms with the demand, or by a combination of these two methods. The first method is limited to systems which are small and sufficiently flexible so that the surges caused by on-off operation of the pumps are not objectionable. The pumps should be of such sizes that the operating and shutoff periods are reasonable in duration—not less than 15 min. Whenever conditions permit, this type of control is the most desirable because it is both economical and dependable. If the requirements of the system are such that on-off control is not feasible, the second or third method must be used, the pumps being operated continuously within the range of the control as required by the load. In general, it is inadvisable to operate a pump at less than 50 per cent of its rated delivery.

The output of a pump may be controlled whether it is driven at a substantially constant speed or at a variable speed. In the former instance, the output is controlled by throttling a valve in the discharge line. Incidentally, the suction valve should never be utilized for this purpose because, if the suction pressure falls below the vapor pressure of the water, serious cavitation in the pump may result. The control valve in the discharge line may be manually operated if the system is small and operators are in constant attendance. For larger pumps and more dependable service, there should be an automatic check valve and a stop valve in the discharge line. The check valve should be installed between the pump and stop valve so that the line pressure may be shut off by the stop valve to permit servicing the check valve.

The check valve should be of a type that will prevent excessive surges in the line if the motor power fails. The swing type of check valve should never be used for this service because of the slam and pressure surge that occurs with this type of valve when the flow tends to reverse. There are self-contained automatic check valves on the market which are nonslamming. These valves are suitable for small pumps, provided that consideration is given to the inherent pressure drop—usually quite high—across the valve. Check valves for pumps having a discharge nozzle of 12 in. or larger should be equipped with an external control device for adjustment of the rate of closing of the valve. Valves of the rotary

plug or butterfly type, with attached controllers, are widely used. Such valves should be adjusted to close, in the event of power failure, at a rate that will minimize water hammer in the system. These valves are well adapted for throttling service and may be controlled by means of hydraulic cylinders (either water or oil), pneumatic cylinders, or electric or air motors. All control valves in the discharge lines of high-lift pumps in the Detroit system are now operated by means of water pressure.

If a check valve is used for throttling the pump output, the control device that adjusts the throttling of the pump should cause the valve to move into the required position slowly, in order to prevent hunting and excessive water hammer in the system. If power failure occurs, however, it is necessary that the valve close rapidly. Therefore, the throttling control must be bypassed by an emergency device to obtain controlled, rapid closure and fulfill the function of a check valve.

Motors and Motor Controls

The two types of electric motors suitable as variable-speed drives for water works pumps are the d-c motor and the wound-rotor a-c motor. The former is widely used in the steel industry, as it is particularly adapted to very accurate control of speed. It is not usually employed for driving water works pumps because of the high cost of the motor itself and of the equipment to produce the d-c power and to control the voltages applied to the motor.

The wound-rotor a-c motor will drive the pump at a fairly constant speed, which is a function of the resistance in the rotor circuit. When the rotor is short-circuited, the motor operates as a squirrel-cage induction motor at almost synchronous speed. It is under this condition that the motor operates the pump at any point along the head-capacity curve. The speed of the motor is reduced by introducing external resistance in the rotor circuit.

Wound-rotor motor controllers of the drum type, which connect a finite number of steps of resistance into the rotor circuit, are available as a packaged item for motors up to approximately 1,000 hp. The control by finite steps is not objectionable, as experience indicates that the variation in output between consecutive steps can be tolerated for a considerable time before corrective changes are required. For motors larger than 1,000 hp, similar control can be obtained by the use of magnetic contactors. The more contactors used, the closer the motor can be controlled to meet the load requirements. Except for unusual conditions, six control steps should meet the requirements for high-lift pumps.

The principle of the water rheostat has been developed by the suppliers of control equipment for large a-c wound-rotor motors. This device consists of three movable electrodes, operated by a motor-driven mechanism that changes the distance between them, and three separate, stationary electrodes in a solution of sodium carbonate. The water evaporated is replenished by a float valve, and the heat generated in the electrolyte is dissipated by a water-cooled heat exchanger. This type of controller is infinitely variable and may be remotely controlled.

Another important method of varying pump speed is to use a constant-speed motor that drives the pump by means of an adjustable-speed slip device, which may be a hydraulic or magnetic coupling. The hydraulic coup-

ling operates on a principle similar to that employed in fluid-drive automobile transmissions, with the addition of necessary torque-limiting controls. The heat losses are absorbed by a heat exchanger, and the torque is regulated to provide full stepless variation in speed by means of manual, automatic, or remote-control devices.

The magnetic coupling consists of two rotating elements, one of which incorporates a single coil or a group of field coils designed to be excited from a d-c source. The rotating element with the excitation coils is connected by shafting to the pump, and the other element is connected by shafting to the driving motor. The torque transmitted by the magnetic coupling is controlled by varying the excitation. The magnetic coupling is self-cooled by the air currents produced by rotation of the coupling elements. The cost and efficiency of the hydraulic and magnetic couplings are believed to be about equal.

For pumps operating under rated conditions, the synchronous motor exhibits the highest efficiency of any of the drives discussed, but, if the discharge valve is throttled to reduce the output below 95 per cent of the rated capacity, the efficiency is less than that of the other methods of control. There is very little difference between the efficiency of the synchronous-motor drive, with either the hydraulic or the magnetic coupling, and that of the wound-rotor motor when the pump is operated at a speed less than 95 per cent of the speed at minimum slip. The wound-rotor motor is considered the simplest and most dependable of the several types of drive for operating pumps at sustained subnormal outputs.

Motor-starting equipment may consist of circuit breakers or magnetic starters with fuses for fault protection. Circuit breakers are considered most desirable for controlling motors for large high-lift pumps, especially where the circuit breakers can be included in switchgear lineup with main-line and branch feeder circuit breakers and where relaying is used to detect faults in the motor circuit other than overload and short circuits.

Motor Characteristics

Synchronous motors have a higher operating efficiency and power factor than squirrel-cage induction motors but can usually be economically justified only if the size is 500 hp or larger. As stated before, wound-rotor induction motors are preferred for driving pumps that must be operated at less than normal output.

Starting torques for high-lift pumps are not a problem, as only the torque of the friction load of the rotating parts need be exceeded. The pull-in torque of synchronous motors for driving the average centrifugal pump should be not less than 100 per cent of rated full-load torque, to provide sufficient power for synchronizing. If the source of power can support the greater demand, motors with 125 per cent pull-in torque may be considered, in order to reduce the number of occasions on which the motor will fail to synchronize.

The normal induction motor has a pullout torque of approximately 225 per cent. Under full load, the motor will continue to operate in the event of a voltage dip to not less than 67 per cent of normal. If the voltage drops below this percentage for an appreciable period, the motor will trip on overload, but, if the drop is only momen-

tary, no serious trouble will occur with the induction motor, as it will accelerate to normal speed on restoration of normal voltage.

Synchronous motors having 150 per cent pullout torque will fall out of synchronism under rated load if the voltage dips to 67 per cent of rated voltage. It is considered advisable to provide the advantage of 175 per cent pullout torque, which will permit the motor to stay in synchronism through drops to 57 per cent of rated voltage. If several synchronous motors fall out of synchronism owing to a momentary voltage dip, considerable power is required to bring them all back into step. For this reason, it is necessary to limit the number of such motors that will resynchronize automatically and to require the remaining synchronous motors that have lost synchronism to trip out. The tripped motors may then be restarted by the operators as conditions permit.

The tendency of modern design is toward higher speeds and smaller units. This increases the probability of bearing and packing troubles, as well as vibration and cavitation. For water works service, it is considered advisable to design for the lowest speed that does not adversely affect the satisfactory performance of the pump in all other respects.

It will be noted from Fig. 3 that the horsepower increases only slightly above the rated capacity of the pump. During periods of low demand, when the system pressure is correspondingly low, the pump may be required to operate for considerable periods at low heads. It is, therefore, advisable to select a motor that will not be overloaded under any condition of pump operation. Even more conservative design indicates the selection of a motor with 10 per cent more horsepower than that required by the pump for the following reasons:

1. The pump as actually built will probably have greater capacity than the maximum guaranteed capacity and will therefore require more horsepower. This condition usually results because the manufacturer machines the impeller to oversize dimensions so that the pump will exceed the guaranteed capacity, with the intention of reducing the diameter of the impeller, if necessary, after preliminary field performance tests.

2. The greater horsepower of the motor permits it to operate continuously through greater voltage dips.

3. The greater horsepower permits more positive synchronizing.

The cleanliness, ventilation, temperature, and humidity of high-lift plants are such that Class A motor insulation normally should have a satisfactory life. The failure of high-lift pumps, however, seriously jeopardizes the health and safety of the community served. It is, therefore, considered vital that all reasonable precautions be taken to insure continuity of service. Thus, consideration should be given to the use of inorganic Class B insulation, not necessarily because of its higher temperature rating, but because it deteriorates at a lower rate than Class A insulation. The longer expected life and the reduced probability of failure at a critical time are regarded as sufficient reasons to justify the additional cost of Class B insulation.

Bearings may be of the sleeve or antifriction type. The former has a number of advantages for high-lift pumps and motors:

1. Sleeve bearings properly aligned and lubricated are long lived.

2. Bearing trouble develops slowly and gives ample warning of needed repairs.

3. Elaborate equipment is not required to renew the bearings completely.

4. The bearings may be of the split type, which permits repair without dismantling of the equipment.

5. Excessive inventory of bearing material is not required; it is readily available on short notice.

Synchronous motors require excitation by direct current, which may be obtained from rectifiers, motor-generator sets, or a generator directly connected to each motor. The disadvantage of rectifiers or motor-generator sets is that their failure will cause the tripping of all motors being excited by them. Therefore, if a common d-c source is used, there should be at least two rectifiers or motor-generator sets operating to supply the excitation, plus one additional unit as standby. Also, each unit should be rated to excite all motors connected thereto and should receive a-c power from separate sources, if possible.

Individual rectifiers or motor-generators may be provided for each synchronous motor. By this arrangement, failure of the rectifier or motor-generator set affects only the synchronous motor to which it is connected. If at all possible, the d-c equipment should be energized from the same source supplying power to the synchronous motor. A d-c generator mounted directly to an extension of the synchronous motor shaft is considered the most reliable arrangement, for the operation of the synchronous motor is dependent only upon the one source of power to which it is connected.

Conclusion

A brief description of the general plan of Detroit's Northeast Station has been presented, and the reasons for the selection of vertical pumps driven by 2,300-v motors have been outlined. Certain principles governing the choice of size and characteristics of centrifugal pumps and the appropriate controls to meet the requirements of high-lift pumping plants have also been discussed.

Wound-rotor induction motors are preferred for driving high-lift pumps at variable speeds, and synchronous motors are preferred for constant-speed drives of 500 hp or larger. Squirrel-cage induction motors are preferred for constant-speed drives smaller than 500 hp.

History of Steam-operated Pumps at Philadelphia

Gerald E. Arnold

A contribution to the Journal by Gerald E. Arnold, Gen. Supt., Water Dept., Philadelphia.

IN 1799 the Philadelphia city council passed an ordinance authorizing a loan of $150,000 for the erection of steam pumps on the Schuylkill River at the foot of Chestnut Street and at Center Square, now the location of City Hall. The installation at Chestnut Street and the river was used to pump water through a tunnel to the reservoir for the other steam pump, located in an ornate marble building in Center Square. The boilers for both engines were wooden boxes 9 ft high, 9 ft wide, and 15 ft long. The firebox inside the boiler was of wrought iron. The Schuylkill pump had a capacity of 1,474,560 ale gallons * of water per day, with a consumption of 70 bu of bituminous coal. The Center Square engine had a capacity of 962,520 ale gallons a day, with a consumption of 55 bu of coal. The total cost of both pumping stations was $275,861.10.

In the course of a few years these works were found insufficient and very expensive, which induced the council to look for a more frugal means of supply. The consequence was the erection of a steam engine at the Fairmount Works (now the site of the Aquarium) which pumped into a reservoir where the Art Museum is now located. The engine was a Bolton and Watt model with a 44-in. cylinder and a 6 ft stroke, working a vertical-action pump 26 in. in diameter with a 6-ft stroke. This engine had a boiler with a cast-iron case and vertical flues of wrought iron. On the duty trial of Sep. 7, 1815, the pump delivered 1,733,622 ale gallons per day, consuming seven cords of wood and carrying 2.5–4-psi steam pressure.

Another high-pressure steam engine, made by Oliver Evan, was placed in service on Dec. 15, 1817. This engine was supplied from four cylinder boilers with a steam pressure of 220 psi. On trial, the engine raised 3,072,656 ale gallons 102 ft in 24 hr, with a consumption of thirteen cords of wood. The cost for pumping 1 mil gal 100 ft high was then $35, compared with $3.15 (cost of purchased power) at present.

Because the supply of water again became inadequate and the Oliver Evan steam engine burst in 1818, the city council passed a resolution to dam the Schuylkill at Fairmount and employ water wheels for pumping all of the water then used by Philadelphia. Work on the dam was commenced Apr. 19, 1819, and the first water flowed over it on Jul. 25, 1821. On Oct. 24, 1822, the steam engines were stopped, in the belief, according to the 1823 report of the water committee, that they would never again be

* One ale gallon equals 1.22 US gal.

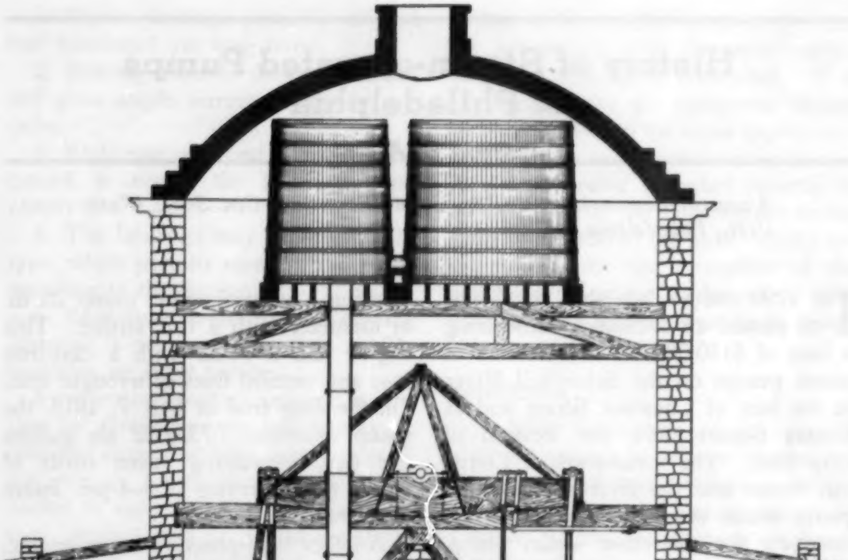

Fig. 1. Center Square Installation

This pump was in use from 1801 to 1816.

wanted. (In 1829 the Center Square building and steam engine were torn down.) Joseph S. Lewis, chairman of the water committee, stated that 1 mil gal of water could be pumped 100 ft for only $1.00 with water power.

From 1822 to the end of 1844 the Fairmount Works supplied water by

water power not only to the city proper —which extended only from Vine Street to South Street, river to river —but also to the districts of Spring Garden and Northern Liberties in the north and to Southwark and Moyamensing in the south. The northern districts, improving rapidly and spreading their borders over higher ground than could at that time be conveniently supplied from Fairmount Dam, jointly decided, over strenuous legal opposition from Philadelphia, to erect their own water works, and the districts of Spring Garden and Northern Liberties constructed a steam-driven plant on the Schuylkill River near Spring Garden Street. The district of Kensington built an independent steam power plant on the Delaware River at the location of the Otis Street Wharf.

The Twenty-fourth Ward in West Philadelphia also built a steam pumping station about 1850. The West Philadelphia plant, now Belmont, was equipped with the most modern steam engines of the times: two Cornish bull engines, each with cylinders 50 in. in diameter and an 8-ft stroke, working pumps 17 in. in diameter with an 8-ft. stroke. In 1854 the Schuylkill station at Spring Garden Street, the Delaware station at Otis Street, and the Twenty-fourth Ward station, all steam operated, were acquired by the city by the Act of Consolidation.

The annual report for 1860 shows that the average steam pumpage at the Schuylkill plant was 7,360,849 gpd, with a duty of 32,000,000 ft-lb per 100 lb of coal. The plant by that time included two reciprocating overhead-beam engines, one reciprocating bell crank engine, and one Cornish overhead-beam engine, to serve six wards.

The Delaware works at Otis Street, serving five wards, had one horizontal high-pressure engine and one beam condensing engine. The average pumpage in 1860 was 2,379,375 gpd, with a duty of only 20,000,000 ft-lb per 100 lb of coal.

In 1860 it was recommended by Chief Engineer Berkenbine that the city erect, at the Schuylkill plant, a Cornish engine of the largest class, with a pumping capacity of 10 mgd. The steam-driven pump was to be used in the event that something happened to the 40-year-old water wheels at Fairmount. It was also suggested that a steam plant be erected at Flat Rock Dam to serve Manayunk (Twenty-first Ward), which then had no water supply other than wells.

In 1868 a side-lever Cornish engine, based on a general design by the chief engineer, was installed at the Schuylkill plant, now called Spring Garden Station. The 10-ft stroke, 72-in. engine and 36-in. pump had a capacity of 7.5 mgd. A sum was appropriated for a new set of boilers and a boilerhouse for the new engine. The original boilers, which had by then been in use 24 years, were almost too unsafe to run, and it was suggested that they be taken out as soon as the boilers intended for the new engine could be erected.

In the same year a contract for two duplex pumps of 5.0-mgd capacity, for the Belmont Cottage pumping station, was awarded to Henry R. Worthington. Also it was reported that the building of the Cornish engine for the Roxborough pumping station at Flat Rock Dam was progressing slowly.

In 1871 the new Belmont plant was completed. The boilers were of the cylinder type, 54 in. in diameter, with

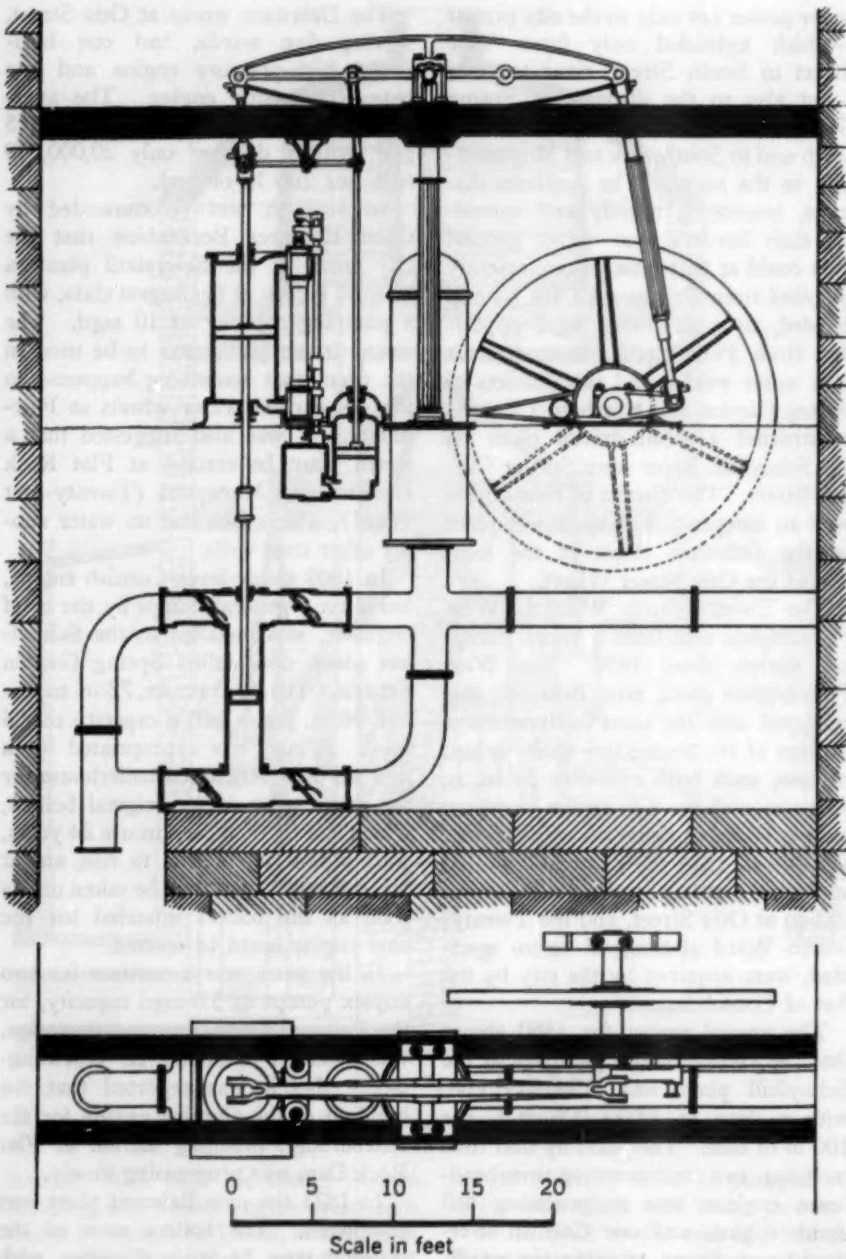

Fig. 2. Schuylkill Station, Engines No. 1 and 2

Built by Merrick and Towne, these engines were installed in 1844.

two 26-in. diameter heaters under them. A report stated that they were safe and reliable, and could run almost continuously without attention, being for those reasons desirable for use in water works, where it is essential that no unnecessary delay occur. On Dec. 11, 1871, the Shawmont steam plant commenced operating, and an auxiliary station was erected in Roxborough to supply the Germantown area. The average pumpage reported for 1871 was as follows for the various stations: Fairmount, 24.2 mgd (water power; all others, steam power); Schuylkill, 6.2; Delaware, 3.0; Belmont, 2.9; Germantown, 0.3; Roxborough, 1.0; total, 37.6 mgd, 65.4 per cent pumped by water power and 34.6 per cent by steam.

In 1873 the Chestnut Hill water works was purchased by the city. The plant contained two independent horizontal steam engines connected to one double-acting pump. The pump received its water supply from a spring-fed well. The boilers were reported as 30 years old at the time of purchase.

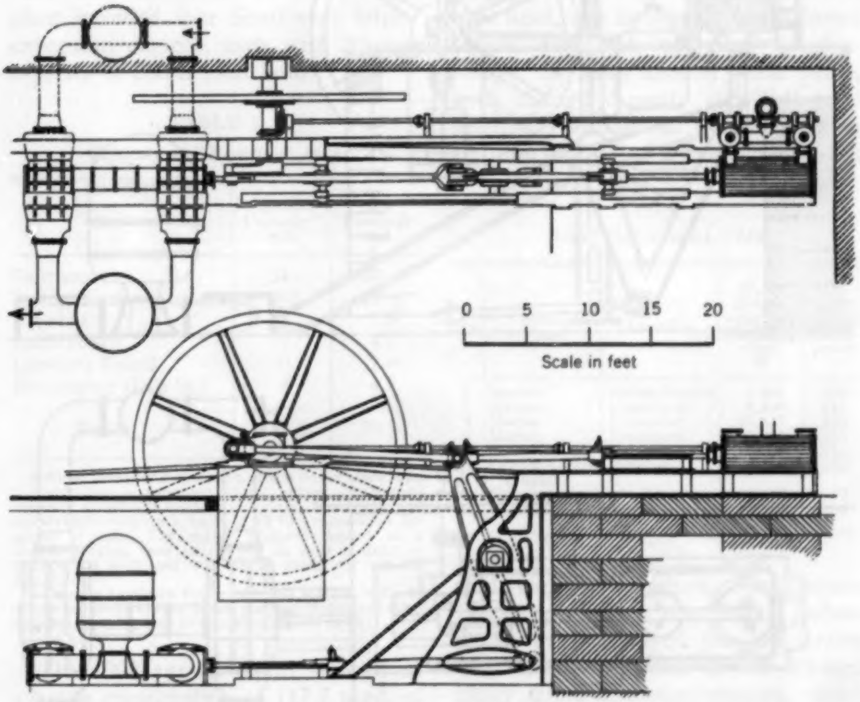

Fig. 3. Delaware Works, Engine No. 1

The Kensington Dist. installed this engine in 1851.

In 1874 Chief Engineer McFadden reported that the entire theoretical pumping capacity of the water department was 104 mgd, of which 44 mgd was water powered and 60 mgd steam powered; the quantity to be relied on

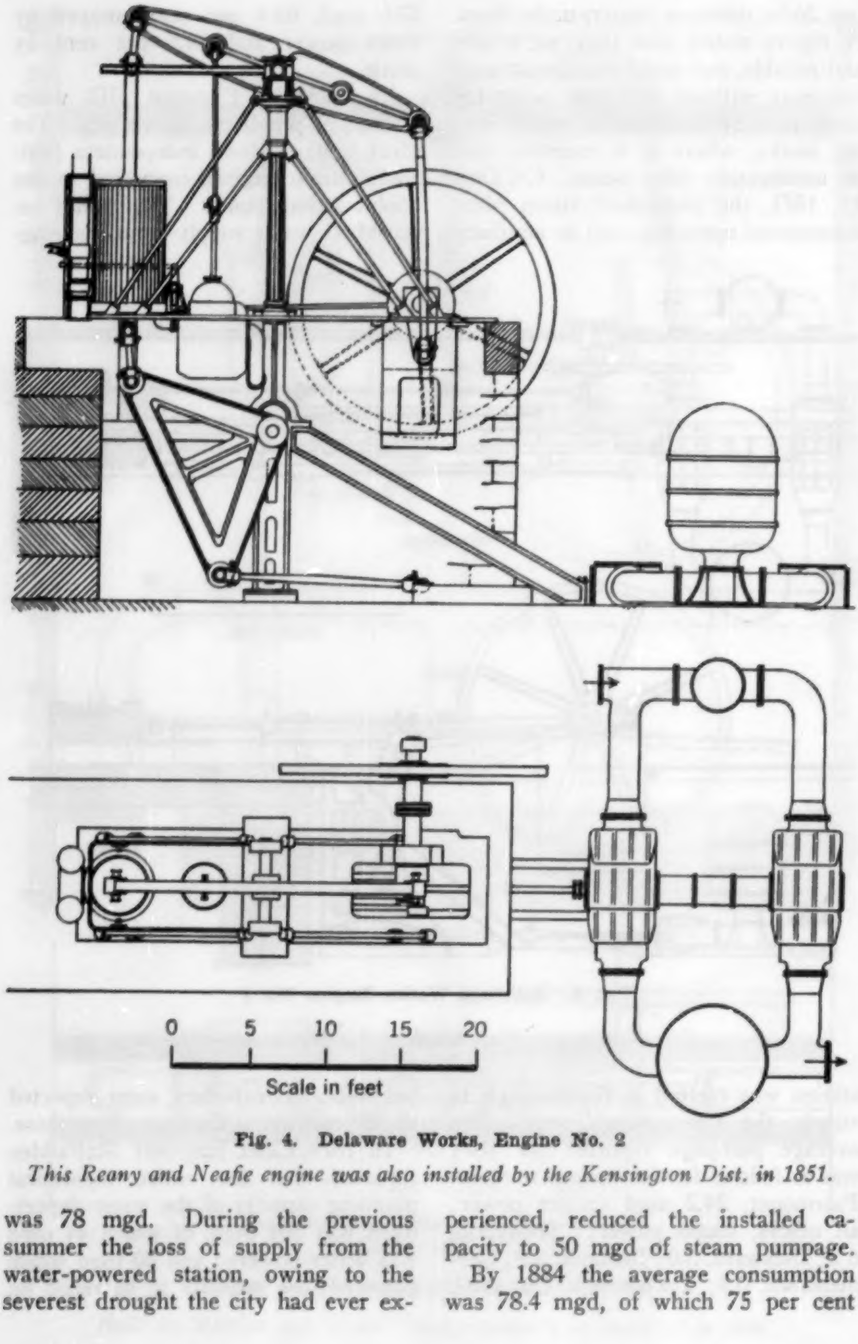

Fig. 4. Delaware Works, Engine No. 2

This Reany and Neafie engine was also installed by the Kensington Dist. in 1851.

was 78 mgd. During the previous summer the loss of supply from the water-powered station, owing to the severest drought the city had ever experienced, reduced the installed capacity to 50 mgd of steam pumpage.

By 1884 the average consumption was 78.4 mgd, of which 75 per cent

was pumped by steam and 25 per cent by water power. The theoretical installed capacity (82 per cent steam, 18 per cent water power) reported in 1886 is shown in Table 1. Boiler performance in the same year is given in Table 2.

Work on the Queen Lane pumping station and reservoir was begun in 1892 and completed in 1894. The plant included four Southwark triple-expansion engines, each with 20-mgd capacity at 260-ft total head.

TABLE 1

Capacity and Pumpage, 1886

Station	Installed Capacity* *mgd*	Avg Pumpage *mgd*
Fairmount	34	20
Spring Garden	90†	40
Belmont	18	7.9
Roxborough	12	4.7
Lardners Point‡	20	2.4
Kensington (Otis St.)	8	4.7
Total	182.5	79.7

* Water power at Fairmount, steam power elsewhere.

† Including a proposed Holly engine of 20-mgd capacity at 165.5 ft head, with a duty of not less than 100,000,000 ft-lb on a basis of 10 lb evaporation per pound of coal. The engine accepted, known as a Gaskill Engine, was guaranteed to give a duty of 110,000,000 ft-lb and was to be ready for use on Jun. 1, 1887.

‡ The old Lardners Point pumping station, with its intake on the Delaware River, was completed and commenced pumping into Wentz Farm Basin in 1877.

The 1908 annual report showed an average consumption of 117.7 mgd, of which 3.48 per cent was water powered and 96.52 per cent steam pumped. There were then seventeen pumping stations, with a total installed capacity of 900 mgd. All of the pumps were of the steam-operated, reciprocating type. The year 1909 saw the completion of the Torresdale filter plant, with twelve Holly triple-expansion engine-driven pumps, each with 20-mgd capacity at 250-ft total head. The engines were powered by fourteen 500-hp horizontal water tube boilers. The pumping units held the world record for duty, yielding 155,000,000 ft-lb per 1,000 lb of steam. The department then included ten pumping stations, with 52 reciprocating pumping engines and a total installed capacity of 1,000 mgd.

In 1915 the first centrifugal turbine pump, with 20-mgd capacity at 360-ft total head, was installed at the Belmont station and was operating satisfactorily. In 1918 another such pump, with 25-mgd capacity at 300-ft total head, was installed at Queen Lane, in addition to the four 20-mgd Southwark

TABLE 2

Boiler Performance, 1886

No.	Boiler Type	Location	Water Evaporated per Pound of Coal *lb*	Commercial Horsepower
5	Marine	Spring Garden	9.080	520
3	Marine	Frankford	9.550	242
3	Marine	Frankford	10.835	233
2	Marine	Frankford	10.986	335
8	Cylinder	Belmont	8.050	616
4	Double-decked tubular	Belmont	9.380	492
2	Plain tubular	Mt. Airy	10.330	92
2	Furnace flue	Roxborough	11.022	230

triple-expansion engines. At Lardners Point, a 40-mgd centrifugal turbine pump was employed for low-service duty to augment the twelve 20-mgd Holly triple-expansion engines, which were already reported as overworked. The year 1918 marked the first use of electric-motor drives for centrifugal pumps. Seven Platt centrifugal units were installed at the Roxborough high-service and booster stations, including two with 6.5-mgd capacity at 85-ft head, two with 3.5 mgd at 85 ft, two with 15 mgd at 9 ft, and one with 7.5 mgd at 9 ft. One of the 15-mgd pumps at the Roxborough booster stations is still operative, all the others

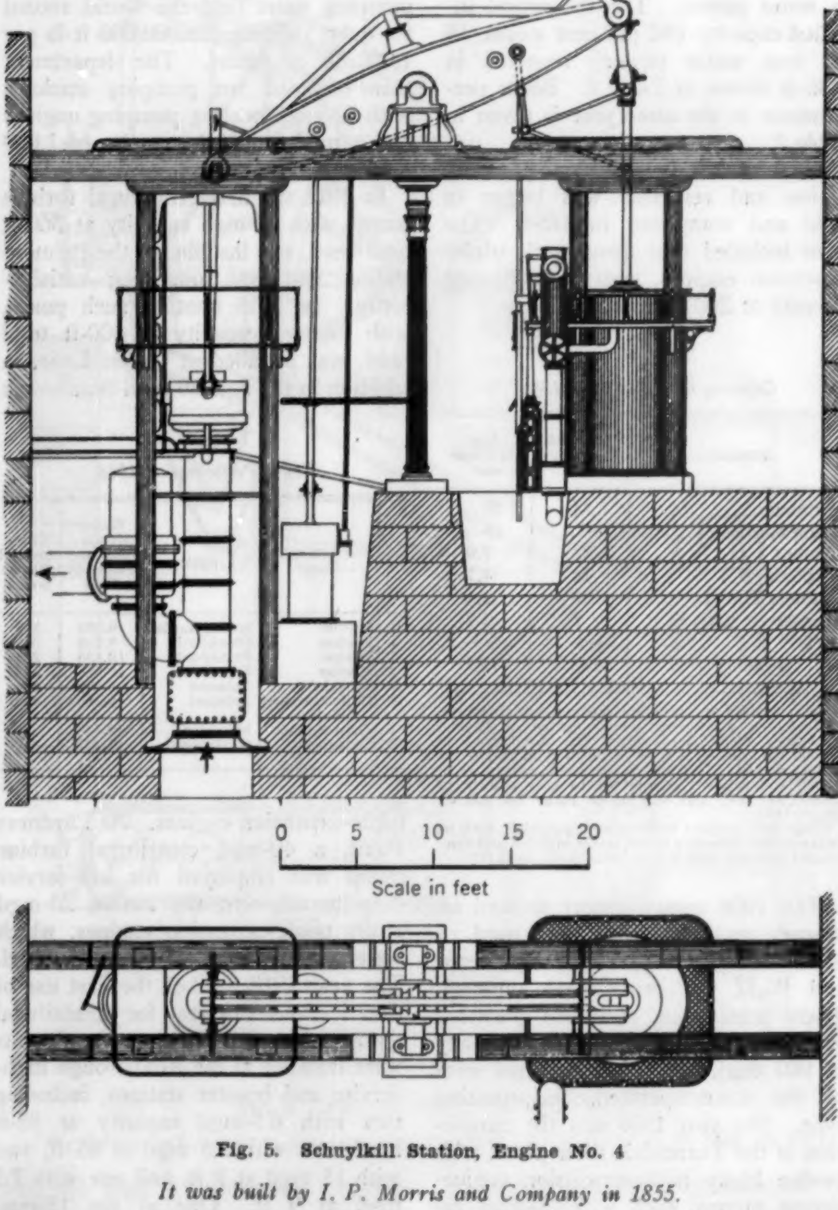

Fig. 5. Schuylkill Station, Engine No. 4

It was built by I. P. Morris and Company in 1855.

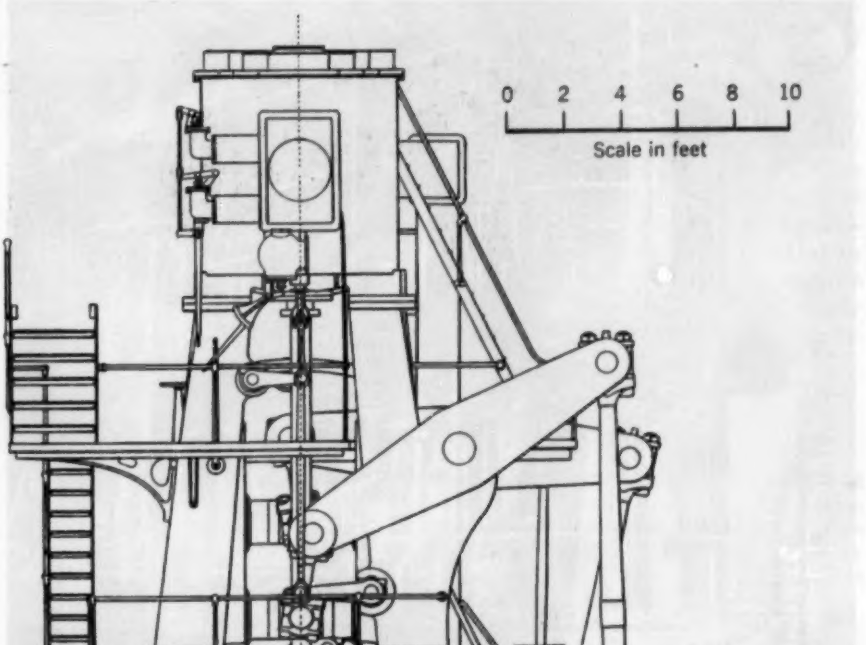

Fig. 6. Schuylkill Station, Compound Engine

Installed in 1876, this engine was built by W. Cramp and Sons.

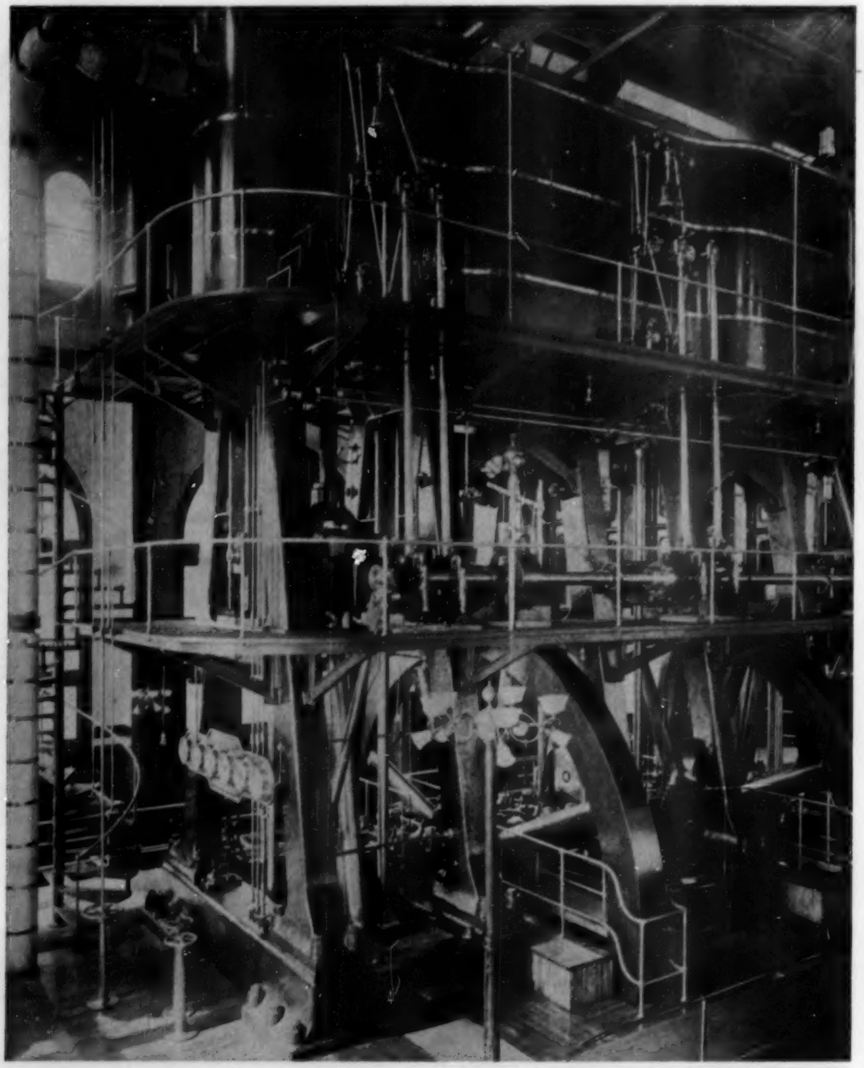

Fig. 7. Torresdale Plant, Holly Triple-Expansion Units

These pumps, twelve of which were installed between 1904 and 1909, were finally scrapped in 1949.

having been replaced in 1922 and 1926 by more modern motor-driven pumps.

Contracts for modification of the Queen Lane plant were let in 1920. Four 20-mgd Southwark units were replaced by four 40-mgd centrifugal pumps, and two 500-hp boilers were added. A 20-mgd centrifugal pump was moved to the Belmont pumping station.

A combination of factors—including failure of the steam plant at Shawmont station in 1926, the rapid advancement in the efficiency of centrifugal pumps and synchronous motors, and favorable rates for purchased power—led the water department to solicit bids on additional electrically operated equipment. By 1929 the various stations had an installed motor-driven pump capacity of 800 mgd.

The year 1949 witnessed the completion of the electrification of Lardners Point pumping station and the construction of the new electric station at Torresdale, and Foxchase pumping station. Putting out the fires in the boilers at Queen Lane pumping station in 1954 concluded the electrification of all pumping equipment owned by the department, which now has an installed capacity of 1,462 mgd in twelve pumping stations. Thus ended the illustrious career of the steam-driven pumps in the 155 years of continuous operation of the Philadelphia water works.

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Meeting Peak Demands at Milwaukee

Edward F. Tanghe

A paper presented on Sep. 29, 1954, at the Wisconsin Section Meeting, Green Bay, Wis., by Edward F. Tanghe, Supt., Water Works, Milwaukee, Wis.

THE peak use of water is increasing at a rate faster than the yearly average, owing to several factors: one is the summertime use of water for air conditioning; another is the more generous use of water for bathing and other domestic requirements, especially on a hot day; the principal contributor to peak demand, however—at least, in Milwaukee, Wis.—is the use of water for lawn sprinkling. In the last three decades there has been a very decided movement of the population from the central, congested parts of the city to the outskirts. Invariably, the newer homes are being built on larger lots with more expansive lawns. Keeping them green during protracted dry spells has resulted in a demand for water at rates taxing the capacity of the utility. These peak demands do not occur very often, and the total amount of water for lawn sprinkling is not a large percentage of the total yearly use, but 50 per cent of plant capacity is required for this use, even though the revenue received for all of the water employed for lawn sprinkling is only 2 per cent of the total.

From 1920 to 1953 the population supplied with water increased 50 per cent, the yearly average use rose 100 per cent, and the peak use (unrestricted) increased 250 per cent. Since 1948 lawn sprinkling between 5 and 8 PM has been restricted to one side of the street on alternate weekdays. With this restriction, the increase in peak demand in the period 1920–53 was 150 per cent. The dispersion of consumers, together with the rise in peak use, has increased the capital cost of the water works 350 per cent during this period (Fig. 1).

The increase in peak use is not uniform throughout the city. The low-service area, which encompasses the older sections of the city, is occupied by commercial and industrial establishments and by residential structures that are mostly small, old, and with very little lawn. The high-service area, largely residential, comprises the newer sections of the city and some suburbs. Two of the latter have numerous large industries and three are primarily residential.

Peak day and instantaneous peak rates, expressed as percentages of the yearly average day, are shown in Table 1. The ratio of peak to average day is not changed for any of the areas by the introduction of sprinkling restrictions, nor is the total use of water curtailed. The primary benefit derived from the mild sprinkling restrictions is the reduction in the high peak rate of use at about 7 PM on a hot day.

In 1930 Milwaukee installed its first elevated steel tank. This installation was made primarily to correct a poor pressure situation in one of the outlying areas. The original intention was to allow the tank to float on the line, but it was soon discovered that, on a hot day, the tank would be dry before

the evening peak arrived. Consequently, it was decided not to release the contents of the tank until 5 PM, when a time switch would allow the water to enter the distribution system. This method of operation proved very satisfactory, but to supply any considerable portion of peak consumption by means of elevated storage would have been very costly, and elevated tanks in residential areas are not especially desirable.

About 20 years ago Milwaukee adopted the plan of utilizing large steel standpipes as reservoirs to be filled at night under normal distribution sys-

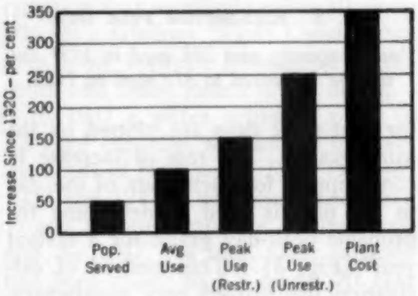

Fig. 1. Rate of Growth, 1920–53

"Peak Use (Restr.)" refers to lawn sprinkling restrictions from 5 to 8 PM.

tem pressure, the stored water being pumped into the system during the peak demand period. This arrangement allows more uniform operation of the pumps at the major stations, lowers the peak demands on the filter plant and the pumping stations, and decreases the required capacities of the feeder mains from the pumping stations to distant areas. Because, during the peak demand period, the water comes from these storage units, which are closer to the points of use than the pumping stations are, better pressures are maintained in the outlying areas.

Meeting peak demands by this method amounts to only a fraction of the cost of supplying the equivalent rate from the primary source. It makes good use of the large feeder mains during the night, decreases the work of starting and stopping pumps at the major stations on a hot day, and, most important, furnishes a great deal of extra supply capacity during the peak demand period.

Recording flowmeters on large feeder mains are used to obtain information on the rates of use by the suburbs and by various areas in the city. Charts obtained from these recorders enable

TABLE 1

Area	Peak Day Rate	Instantaneous Peak Rate	
		Unrestricted	Restricted
	per cent of avg day		
Entire system	165	300	240
Low service	150	200	200
High service	175	380	250
Industrial suburb	200–250	400	300
Residential suburb	300	900	600

the determination of the amount of storage required to equalize the peak-day consumption for any particular area. Gages placed on hydrants (Fig. 2) and at scattered points throughout the city, preferably at high elevations, provide a continuous record of summertime pressure conditions in the distribution system. Information on the locale of excessive peak-day pressure losses has been extremely valuable in planning feeder main installations.

It has been customary to assume that the peak day's consumption would be 50 per cent more than that of the average day, and that the instantaneous peak rate would be 50 per cent above

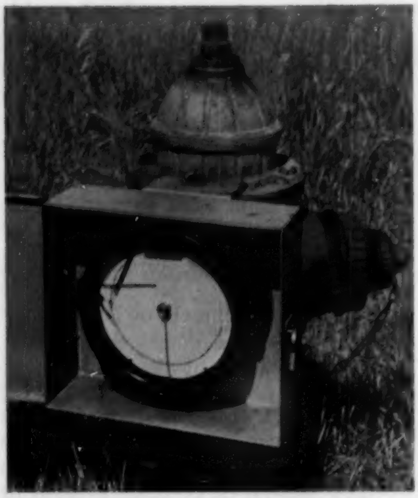

Fig. 2. Recording Pressure Gage

Such gages assist in the determination of areas with excessive pressure losses.

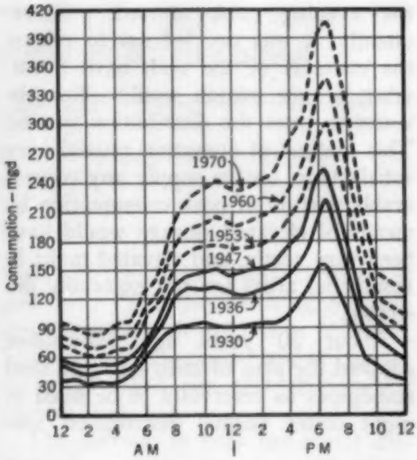

Fig. 3. High-Service Peak Days

Pump capacity was 268 mgd in 1954 and will be increased to 312 mgd in 1955.

the peak-day rate. This may still be a pretty good rule in some localities, but, as illustrated by the ratios in Table 1, the ratio of peak to average use will vary with the character of the neighborhood. In attempting to determine the amount of storage necessary to equalize the peak day demand, information about the varying rate of water use is of vital importance. No average figure can be applied to all areas. Comparing data obtained for four different areas, it was found that the amount of equalizing storage required varied from 25 to 150 per cent of the yearly average day with no sprinkling restrictions. The variation was from 25 to 100 per cent when mild evening sprinkling restrictions were in effect.

Milwaukee is now embarking on a program of installing large storage units. To determine the amount of storage required for future peak days, the 24-hr water consumption charts for past peak days are plotted on the same graph. The rate of increase in consumption for each hour of the day in the past is used to determine the probable peak-day graph for a distant year (Fig. 3). This method of calculation has proved very satisfactory.

Placing storage units at scattered points in the distribution system instead of at one location permits rapid filling during the night and reduces the amount of feeder main capacity required to get the water from the storage tanks to the areas of use. The rate of pumping from these units is limited by the capacity of the mains supplied, the amount of storage, and the number of hours of booster pumping necessary. The volume of storage at any one location is governed by the amount of water which the feeder main to that area can supply in a limited time. Most of these units are intended for summer operation only, as there is no difficulty in supplying adequate quantities of water with good pressures at other times.

Problems of Rapid Population Growth in Florida

Charles E. Richheimer

A revised version of a paper presented on Oct. 12, 1953, at the Florida Section Meeting, Miami, Fla., by Charles E. Richheimer, Partner, Reynolds, Smith & Hills, Jacksonville, Fla.

THE problem of meeting demands on water systems due to extremely rapid population increases is a very real one in Florida, where the increases are, in reality, influxes, abetted by the usual natural processes. This paper uses two water systems to illustrate a situation that seemingly exists all along Florida's fabulous "Gold Coast," that area lying between Homestead in the south and Palm Beach in the north.

In 1937 a water softening plant of 1.5-mgd capacity was ample to meet the needs of Hollywood, Fla. Between 1938 and 1941 it was found necessary to add 0.5-mgd capacity to the plant, and, by 1947, the total plant capacity had been raised to 4.3 mgd. At that time it was estimated that further additions would not be required until about 1957. By 1951, however, the demand on the plant exceeded 5 mgd. In 1953 its capacity was increased to 8.6 mgd, with provision for a further increase of 2.7 mgd in a 60-day period, if it should ever be warranted. In 1937 there were 1,577 consumer meters on the municipal water system of Hollywood; by 1941 there were 2,420; by 1947, 3,546; and by 1951, 6,464.

Hollywood's sea water–regenerated cation-exchange softening plant is set up on a unit basis, so that additions can be and are made when required. Raw water is obtained from wells, with new ones placed in service as needed.

In 1945 the population of North Miami Beach was approximately 2,000, living in approximately 500 residences. By 1948 it had increased to 3,000, and the number of residences to 700. At that time no municipal water system existed, each residence being served by an individual shallow well.

A $375,000 water distribution system, serving the built-up area of North Miami Beach with water purchased by the city at wholesale from a privately owned softening plant, began operating during 1949, with approximately 400 consumer connections. By the end of the year it was apparent that the demand for water in North Miami Beach and adjacent communities—Biscayne Gardens, Sunny Isles, Golden Beach, and Golden Shores—was increasing so rapidly that it would be advantageous for the city to acquire the separate privately owned distribution systems and small water plants then serving the residents of these areas. North Miami Beach could then operate all of them in an integrated manner, utilizing the privately owned (Sunny Isles Water Co.) softening plant as the source of supply. Financial arrangements were made, and $1,100,000 worth of revenue certificates were sold by the city, the proceeds being used to purchase the other systems, rehabilitate and increase the capacity of the Sunny Isles Water Co. softening plant facilities, and extend and tie the distribution systems into a consolidated system.

On Feb. 1, 1951, the North Miami Beach Consolidated Water System

served 1,013 consumer accounts. Only 6 months later, on Jul. 31, the system had 1,611 accounts, and, by Feb. 1, 1952, the number was 2,289. A similar trend was shown in the quantity of water sold per month, which slightly more than doubled during the year 1951–52.

By the middle of 1952 the expanded facilities were no longer adequate to meet the demands upon the system. As of Jul. 31, there were 3,128 consumer accounts, an increase of practically 100 per cent in a period of 12 months. Furthermore, the area served was just beginning to grow in earnest —new real estate developments, residential in character, were springing up all over the landscape, and it was easily apparent that further system expansion was necessary. Additional financing, by the issuance of revenue certificates in the amount of $2,680,000, was obtained; the 1949 issue of $1,100,000 was retired; and construction contracts for further enlargement of facilities were let, all by March 1953.

As evidence of the continuing growth of the system, there were, on Jul. 31, 1953, 6,084 consumer services —again almost a 100 per cent increase over the previous July. On Jul. 31, 1954, total services had reached 8,376, a 12-month increase of nearly 38 per cent. Consumption of water has increased in proportion: Jul. 31, 1951–52, 370.1 mil gal; Jul. 31, 1952–53, 580.5 mil gal; Jul. 31, 1953–54, 779.8 mil gal; Jul. 31, 1954–55 (estimated), 940 mil gal.

The design of facilities to meet such rapidly increasing demands is, of course, a matter of great concern. By designing all plant components on a unit basis, North Miami Beach has been able to expand its plant when needed. As at Hollywood, raw water is obtained from wells, and more can be placed in service to meet requirements.

The US Bureau of the Census predicts that, between 1950 and 1960, Florida will show a population gain of 34 per cent, surpassing every other state in the Union. Based on past experience, it seems likely that a very large part of the total population increase in Florida will occur in the "Gold Coast" area. In water systems serving communities whose population growth is similar to that for the United States as a whole, the problems inherent in providing facilities for the future are relatively simple when compared to the difficulties in communities whose growth is as phenomenal as that of Hollywood and North Miami Beach. There is seemingly no simple answer; the engineer must rely chiefly on his past knowledge and experience in the particular area involved. The race to finance and construct the additional facilities required by new demands may, on occasion, cause the engineer forecaster to feel that he should consult a fortune teller or astrologist. Nevertheless, the water demands of the cities discussed have largely been met up to the present.

Financing expansion programs presents quite a problem in itself. Naturally, systems cannot expand in geometrical proportion every year; yet, in 1949, North Miami Beach served only 400 consumers, while, by the end of 1954, there were more than 9,000. The system is now designed and being constructed to serve approximately 10,000 consumers, although the investment bankers regarded as highly optimistic the 1952 estimate of a minimum of 8,400 consumers by Jul. 31, 1961. This figure has, of course, already been exceeded, and a new expansion program is now being planned.

Quality of Arizona Municipal Supplies

George W. Marx

A paper presented on Apr. 22, 1954, at the Arizona Section Meeting, Tucson, Ariz., by George W. Marx, Director & Chief Engr., Bureau of Sanitation, State Dept. of Health, Phoenix, Ariz.

THIS paper will discuss briefly the quality of Arizona municipal supplies, with particular reference to certain constituents that present special problems for some communities in that state.

Very few Arizona communities take their supply from surface waters that are free of all pollution. Flagstaff has a potable source of snow water from San Francisco Peaks. Even there, however, bacterial contamination occurs at points in the gravity line and at the reservoirs, so that chlorination is necessary. Unpolluted ground waters are decreasing, particularly in the more densely populated municipal fringe areas where sewers have not been extended and individual sewage systems are in use. In addition, the heavy demand on ground water in some irrigated areas has lowered the water table, with resultant loss of dilution and increase in chemical concentration.

The chlorination of ground waters as a means of safeguarding the public health is becoming a general practice, and treated surface waters are used to obtain an adequate supply at Phoenix, Flagstaff, Yuma, Williams, Prescott, St. Johns, and Winslow. The last will probably abandon its surface supply as a main source in the near future, in favor of a new well field recently developed. All other Arizona communities use ground water in the form of well supplies, infiltration galleries, or springs.

The water supply system, in all its parts, should be free from sanitary defects and health hazards, and all those known to be present should be systematically removed. State health department approval of public water supplies is contingent upon the existence of:

1. Regulations prohibiting connections or arrangements by which liquids or other substances of unsafe, unknown, or questionable quality may be discharged or drawn into the public water supply. (Such regulations are contained in the state sanitary code. Cross connections are not permitted and many have been removed.)

2. Provisions to enforce these rules effectively on all new installations, including a review of plans and specifications.

3. A continuing program to detect health hazards and sanitary defects within the water distribution system. Local sanitarians have been quite cooperative in reporting any defects they find. The establishment of a state plumbing code would be of assistance in preventing certain types of cross connections.

Chemical Quality

In Arizona, where water is scarce, some communities (*1*) are unable to find a supply that will meet the standards set by the US Public Health Service (*2*). A number of supplies have total-salt concentrations as high as 2,000 ppm. Such concentrations impart an objectionable taste to the water, although they are not harmful to normal individuals. In areas where high salt concentrations occur, bottled-water companies do a thriving business.

The majority of the domestic or community supplies have relatively hard water, owing to the presence of calcium and magnesium. Home softeners are used in many places.

In some areas of the United States and Canada, it has been found that an excess of nitrates causes methemoglobinemia, with resultant severe cyanosis, in infants fed with formulas containing such water. A toxic limit of 20 ppm has been suggested. The relationship between nitrate concentration and methemoglobinemia ("blue babies") has not been established in Arizona. Some community supplies have fairly high nitrate concentrations. In fact, there are individual domestic wells with concentrations in excess of 300 ppm. The author, however, knows of only three cases of methemoglobinemia in the state. In every instance, the physician prescribed nitrate-free bottled water for the babies' formulas. The relatively low incidence of this disease in Arizona may be due to the fact that physicians have been sufficiently alerted to the problem.

The relatively high sodium concentrations in some Arizona public supplies are ordinarily not significant from a health standpoint, as the human system will take on only its normal requirements and waste the balance. For reasons that are not completely clear, however, the mechanisms responsible for maintaining a constant sodium content in the body, despite variations in sodium intake, may fail to function properly in several very common diseases of the heart, kidney, and liver. Some patients with such diseases are unable to rid themselves of sodium, and, consequently, large amounts of sodium-containing fluid (extracellular fluid) accumulate, a condition known as edema. It appears that the fluid retention may largely be prevented, or, if already present, may be dissipated by restriction of the amount of sodium ingested. In prescribing sodium-free diets, it is often forgotten that domestic water may contain this element, either naturally or as a result of cation-exchange softening. The sodium concentration of the water may be a significant factor in such situations.

Fluoride Study

It has been quite well established that an optimum amount of fluoride in domestic water is a valuable means of promoting dental health by preventing caries. Excessive concentrations, however, are associated with a hypoplasia of the teeth known as dental fluorosis or mottled enamel. The severity of fluorosis depends upon the concentration of fluorides in the water. In the East and Middle West, the range of fluoride concentration most effective in preventing dental caries was found to be approximately 1.0–1.5 ppm, well below the critical amount causing dental fluorosis. (The mean annual temperature in these areas is approximately 50°F.)

In Arizona, conditions are somewhat different. Natural fluorides are found

in nearly all potable waters, with the highest concentrations—some considerably greater than 1.5 ppm—in the southern counties. Concentrations up to approximately 0.6–0.8 ppm seem to harden Arizona children's teeth and make them resistant to decay. If children in this state, during the formation of their permanent teeth, drink water containing more than 0.8 ppm fluoride, however, dental fluorosis or mottling will develop. Because fluoridation of potable waters was being advocated without consideration of climatic conditions in Arizona, the State Dept. of Health requested the US Public Health Service to conduct a study on the matter. A report (*3*) published in 1953 is worth quoting at length:

The Arizona communities of Yuma, Tempe, Tucson, Chandler, Casa Grande, and Florence were selected for initial study. . . . [Table 1 shows the sources of supply, types of treatment, fluoride content, and fluorosis indexes for these cities.]

These six communities met the necessary requirements for investigation. They had water supplies with adequate continuity and with fluoride concentrations ranging around 1.0 ppm. They were of sufficient size to yield a sample of native-born children large enough to be significant. . . . They had mean annual temperatures ranging from 67° to 72°F, with an average mean annual temperature of approximately 70°F. This area is consistently reported as one of the hottest inhabited areas in the United States, exceeded in temperature only by certain communities adjacent to Death Valley, Calif.

Only children who had consumed water from the common municipal supply continuously from birth through their ninth year were included in the study. Children who experienced interruption in the continuity of consumption of the community water for periods of more than 30 days in any one calendar year were excluded. The remaining children served as study material.

The community fluorosis index may be used for an objective measurement of the extent of endemic dental fluorosis. The direct relationship between fluoride concentration and fluorosis noted in prior investigations is evident. As the fluoride concentration rises, the community fluorosis index is increased and the number of children without visible fluorosis is reduced. The community fluorosis index ranges from 0.21, associated with 0.4 ppm of fluoride at Yuma, to 1.12 for Florence, which has 1.2 ppm of fluoride in its water supply.

Comparison of the data [with data from midwestern communities having similar fluoride concentrations and mean annual temperatures of approximately 50°F] reveals that the Arizona communities have a somewhat higher percentage of children affected by fluorosis than communities with a cooler climate and comparable fluoride concentrations in their water supplies. There is also a wider distribution throughout the fluorosis classification. Some of the Arizona children present moderate to severe fluorosis associated with exposure to less than the generally recommended fluoride concentration of 1.0 ppm.

Dean has stated that a community fluorosis index below 0.4 is of little or no public health concern. He considers the range from 0.4 to 0.6 as borderline. For indexes above 0.6 the removal of excessive fluorides from the water is recommended. . . . [The] fluorosis indexes for communities with fluoride concentrations above 0.5 ppm are considerably higher in the Arizona communities [than in the midwestern cities]. Yuma, Ariz., and Marion, Ohio, both have fluoride concentrations of 0.4 ppm and fluorosis indexes of 0.21 and 0.25, respectively. As the fluoride concentration rises, the disparity between indexes becomes marked, so that Florence, Ariz.,

and East Moline, Ill., with fluoride concentrations of 1.2 ppm, present fluorosis indexes of 1.12 and 0.49, respectively.

The fluorosis indexes for the two groups of communities have been plotted on [Fig. 1].

The least-squares method was used to calculate the index lines. . . . The line for the Arizona communities crosses from the negative area into the borderline zone at 0.6 ppm and into the objectionable zone at 0.8 ppm.

These data would indicate that the children residing in the Arizona communities under consideration develop twice as much fluorosis as midwestern children

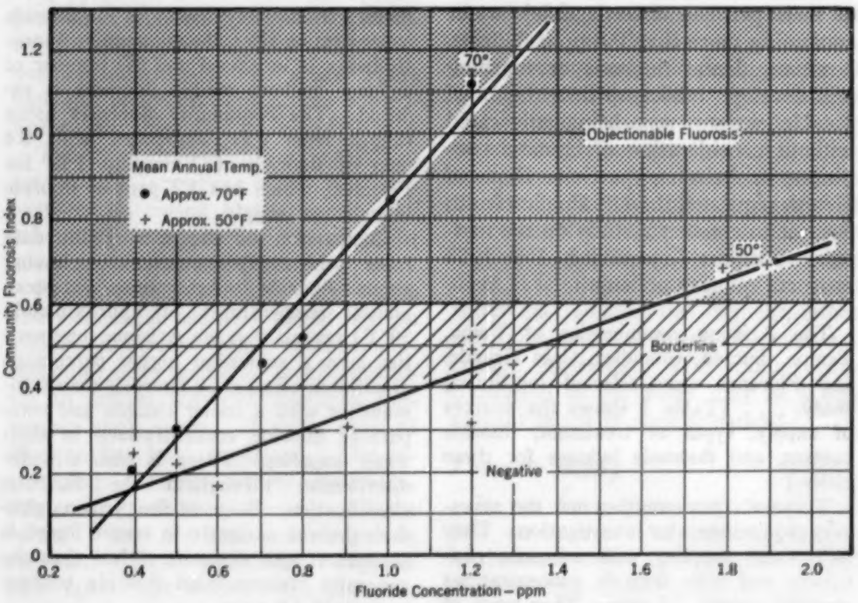

Fig. 1. Fluoride Content and Fluorosis Index

The curves show the relationship between the fluoride concentration of municipal waters and the fluorosis index for communities with mean annual temperatures of approximately 50°F (Midwest) and 70°F (Arizona).

for the Arizona group has a much steeper slope than that representing the midwestern communities. The index line for the Arizona communities accelerates at approximately twice the rate as the one for the midwestern communities. The line for the midwestern cities crosses from the negative area into the borderline zone at approximately 1.1 ppm and from the borderline into the objectionable zone at 1.7 ppm. On the other hand, the

when exposed to water containing the same concentration of fluoride.

Climatological Variables

About two-thirds of man's total fluid intake is water; the remainder, other fluid substances. Except for temporary circumstances of an emotional nature, the amount of fluid ingested is determined by water deficiency. Every bit of body water lost must be replaced, and the re-

placement amounts are obligatory. (In growing children fluid intake may be slightly greater than water loss since some additional water is needed to build new tissues, but generally speaking, water intake and water loss will be equal over a 24-hr period.)

Excessive temperatures result in a bodily demand for fluid over and above that usually required for normal physiological processes. . . . When environmental temperatures rise above skin temperature (92° to 95°F), the only method by which the body can cool itself is vaporization. Heat loss can no longer be effected by radiation or conduction. The water output of the body is therefore increased in proportion to the need for increased vaporization. It follows that there will be an equal increase in the amount of water ingested in order to maintain body water balance.

The extremely high temperature occurring in the southwestern communities is undoubtedly a major factor contributing to the increased severity of endemic fluorosis observed in the Arizona children through its influence on water consumption.

Nonclimatic Variables

The Arizona area under consideration is desert country with very little rainfall. Consequently, all productive land is under irrigation. Since many water supplies in Arizona contain fluoride in some amount, the soil may potentially have fluoride added to it by irrigation. Smith and associates . . . were unable to show any appreciable increase in the uptake of fluoride by grains and vegetables, even when concentrations up to 3,200 ppm were artificially added to the soil in which they were grown. In a comprehensive review of the literature, McClure . . . concludes that fluoride in soil has little or no influence on the fluoride content of edible plant produce. Increased fluoride intake through use of food products grown in soil irrigated with water containing the amounts of fluoride naturally occurring in Arizona therefore seems extremely unlikely.

TABLE 1

Fluoride Content and Fluorosis in Arizona Communities

Community	Source of Supply	Treatment	Fluoride Content *ppm*	Fluorosis Index
Yuma	Colorado River	desilting; aluminum sulfate; flocculation; copper sulfate; filtration; chlorination	0.4	0.21
Tempe	4 wells	chlorination	0.5	0.30
Tucson	17 wells	chlorination; ammoniation	0.7	0.46
Chandler	4 wells	none	0.8	0.52
Casa Grande	5 wells	none	1.0	0.85
Florence	4 wells	none	1.2	1.12

One other nonclimatic factor should be recognized when attempting to account for the observed regional differences in the severity of fluorosis. Generally speaking, the children included in the Arizona group were of Spanish descent (83 per cent). Their dietary staple, beans, is usually prepared by boiling for rather long periods of time. Since boiling in fluoride-bearing water results in a concentration of the fluoride ion in many cooked vegetables . . . , there may have been an increase in the dietary fluoride

intake of this group to a greater degree than would be observed for a group of children on a more varied diet. It was not within the scope of this study to measure the influences of dietary variables upon fluoride intake.

The real fluoride problem in such Arizona communities as Ajo, where the concentration is 4.5 ppm, is removal rather than addition. The US Public Health Service has for some time been carrying on research to develop a practical method of removing fluorides from municipal supplies. Pilot plant studies at Britton, S.D., and Bartlett, Tex., report progress (*4*).

The Arizona Dept. of Health has a study under way at Ajo, in collaboration with the US Public Health Service. Approximately 5 years ago defluoridation equipment was installed at the Ajo school, located in the center of town. Defluoridated water is provided in drinking fountains at the school for children up to 12 years of age. In addition, such water may be obtained by parents from taps provided by the school outside the buildings. There appears to have been some beneficial effect in the lower age group (6–8 years), as indicated by examination of the permanent teeth of the children. It will be interesting to note the results during the next several years.

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3. Galagan, D. J. & Lamson, G. G. Climate and Endemic Dental Fluorosis. *Pub. Health Rpts.*, **68**: 497 (1953).
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Addendum to Cast-Iron Main Installation Standards

The portion of the Specifications for Installation of Cast-Iron Water Mains—AWWA C600-49T (December 1949 Journal, Vol. 41, p. 1079) now titled, "Section 9—Jointing," is to be retitled, "Section 9a—Jointing Bell-and-Spigot Pipe." No change in subsections 9.1 through 9.16 is to be made, other than renumbering them 9a.1, 9a.2, etc. The second note (referring to mechanical joints) following the old Sec. 9.16 is to be deleted, and a new section, as given below, is to be inserted:

Section 9b—Jointing Mechanical-Joint Pipe

Sec. 9b.1—Prior Requirements Apply

The general requirements in Sections 1–8 inclusive shall apply except that, where the terms "bell" and/or "spigot" are there used, they shall be considered to refer to the bell and spigot ends of the lengths of mechanical-joint pipe.

Sec. 9b.2—Variations in Dimensions

The outside diameter of the spigot end of bell-and-spigot pipe varies with the type, size, and class of pipe. There is only one joint size for each diameter of mechanical-joint pipe. Thus, difficulty may be met when attempts are made to connect existing bell-and-spigot lines to mechanical-joint pipe. When such a connection must be made, an adapter having a fitting bell and a mechanical-joint socket is manufactured and may be used.*

* If the existing line ends in a spigot, either a standard sleeve or a special fitting consisting of a bell and mechanical-joint socket may be used, provided that the fitting between the spigot end of the existing line and the bell to be connected to it is consistent with the normal fit of bell-and-spigot pipe.

Sec. 9b.3—Cleaning and Assembling Joint

The last 8 in. outside of the spigot and inside of the bell of mechanical-joint pipe shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter from the joint, and then painted with a soap solution made by dissolving one-half cup of granulated soap in 1 gal of water. The cast-iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket or bell end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge toward the gland.

Sec. 9b.4—Bolting of Joint

The entire section of the pipe shall be pushed forward to seat the spigot end in the bell. The gasket shall then be pressed into place within the bell, being careful to have the gasket evenly located around the entire joint. The cast-iron gland shall be moved along the pipe into position for bolting, all of the bolts inserted, and the nuts screwed up tightly with the fingers.

All nuts shall be tightened with a suitable (preferably torque-limiting) wrench. The torque for various sizes of bolts shall be as follows:

Size *in.*	Range of Torque *ft-lb*
⅝	40– 60
¾	60– 90
1	70–100
1¼	90–120

Nuts spaced 180 deg apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland.

Reference should be made to the "Notes on Method of Installation" included in American Standard Specifications for a Mechanical Joint for Cast Iron Pressure Pipe and Fittings—A21.11 (AWWA C111).

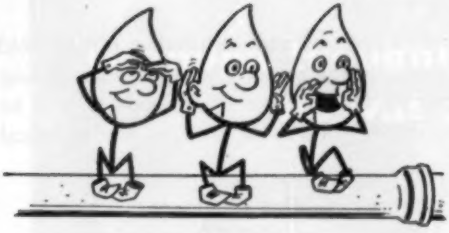
Sec. 9b.5—Permissible Deflection in Mechanical-Joint Pipe

Whenever it is desirable to deflect mechanical-joint pipe in order to form a long-radius curve, the amount of deflection shall not exceed the maximum limits shown in the table below.

Maximum Permissible Deflection in Laying Mechanical-Joint Pipe*

Size of Pipe *in.*	Max. Permissible Deflection per Length—*in.*				Approx. Radius of Curve Produced by Succession of Joints—*ft*			
	12-ft Length	16-ft Length	18-ft Length	20-ft Length	12-ft Length	16-ft Length	18-ft Length	20-ft Length
3	21	28	31		85	110	125	
4	21	28	31		85	110	125	
6	18	24	27		100	130	145	
8	13	18	20		130	170	195	
10	13	18	20		130	170	195	
12	13	18	20	22	130	170	195	220
14	9	12	13½	15	190	250	285	320
16	9	12	13½	15	190	250	285	320
18	7½	10	11	12	230	300	340	380
20	7½	10	11	12	230	300	340	380
24	6	8	9	10	300	400	450	500
30	6	8	9	10	300	400	450	500
36	5	7	8		330	440	500	
42	5	6	7½		340	450	510	
48	5	6	7½		340	450	510	

*** Pipe conforming to A21.2 (pit cast) is commonly made in 12-ft lengths; to A21.6 (centrifugally cast in metal molds), in 12- and 18-ft lengths; and to A21.8 (centrifugally cast in sand-lined molds), in 16-, 16½-, and 20-ft lengths.**



Percolation and Runoff

A new year finds water anything but stagnant. More than merely up to the minute, too, it is now being pegged by aeronautical engineers as the key to the attainment of "escape velocity"—that is, the speed of 25,000 mph, at which a craft could escape the earth and travel at will, limited only by supply problems and human needs. In the unlocking of this newest horizon of our scientists, water would act in one of its familiar roles—that of a cooling agent, being pumped through the porous wings and structures of the craft to carry off the tremendous heat of friction as steam. With heat enough, despite the intense cold at 7 to 25 miles above the earth, to melt aluminum at 3,750 mph and to melt steel at 4,500 mph, just imagine what a market for water at 25,000 mph—not only nonconserved use either, but nonconservable if water is really gonna wash a man right out of the air and send him on his way.

On quite the other hand, just as much for those interested in coming to a quick stop has water been found "the thing." Thus, in Air Force tests of the impact sustained by a flier bailing out of a jet plane traveling at a speed faster than sound, water again is the key—the testing device being a rocket-propelled sled already gunned to speeds of more than 600 mph along a railway track at Holloman Air Force Base in New Mexico and then stopped within 400 ft in 1½ sec by troughs of water. How Lt. Col. John P. Stapp, the human guinea pig involved, takes the jolt we don't quite understand, but water gives it, and is to continue giving it at speeds up to 800 mph, which will result in gravity forces up to 100 G's. Gee!

What price water in this high society is, unfortunately, not the question, for in 1955, as in the past, water works men are going to have to continue worrying about such mundane matters as more water, more appreciation, and more money. By 1956, the year of AWWA's 75th birthday, perhaps even water workers will attain escape velocity as far as these earth-bound problems are concerned. We wouldn't have supposed so on our own, but with Ike, himself, pointing out "I have become convinced that before very long America will almost unanimously look upon water as its single greatest resource," who are we to demur. Such a look, however, will signalize more than just a Happy New Year, at least a Happy New Era.

The same to you, Ike!

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The third International Water Supply Congress and Exhibition will be held in London at the halls of the Royal Horticultural Society, Westminster, during the week of July 18–23, 1955. Acting as North American Reporter will be E. Sherman Chase, Boston consultant, who will also appear on the technical program, as shown below:

Protection of Pipelines Against Water Hammer. C. Dubin (France)
Pumping Station Equipment. Hugh R. Lupton (Great Britain)
Design and Construction of Service Reservoirs and Water Towers. Hilding Bjorklund (Sweden)
Aeration and Deferrisation. L. H. Louwe Kooijmans (Netherlands)
Factors of Safety in Supply and Delivery Systems. A. Vibert (France)
Use of Electronic Apparatus in Water Works Practice, With Special Reference to Waste Detection. R. E. A. Despiegelaere (Belgium)
Comparison Between Slow and Rapid Sand Filters. A. Van de Vloed (Belgium)
Training of Water Works Operators. H. R. Davenport (Great Britain)
Methods of Charging for Water. E. Sherman Chase (US)

Other activities on the program include inspection trips to water supply installations in Brighton, the Colne Valley, Maidstone, the Thames Valley (London's Metropolitan Water Board), Southend, and South Essex. Each of these trips is scheduled as a full day's outing. In addition, half-day trips are planned to East Surrey, the Guildford and Godalming Dist. Water Board, the Metropolitan Water Board, the Rickmansworth and Uxbridge Valley Water Co., the Sutton Dist. Water Co., and—for plain sightseeing—Windsor.

A program of activities is also planned for the ladies, and tours to different parts of the British isles are being arranged for those who wish to spend an additional 5 or 6 days most pleasantly after the conference.

Manufacturers' exhibits will also be shown at the Congress. Copies of the program and further details may be obtained from Leonard Millis, secretary general, 34 Park St., London W.1, England.

(Continued on page 34 P&R)

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W. W. Aultman, after serving since 1951 as assistant director of the Miami, Fla., Dept. of Water & Sewers, has joined the Chicago consulting firm of Alvord, Burdick & Howson. Prior to 1951 he was purification engineer for the Metropolitan Water Dist. of Southern California.

R. D. Murphy has been appointed northern Ohio representative for Hungerford & Terry, Inc., of Clayton, N.J. His headquarters will be at Rm. 2, 6801 Euclid Ave., Cleveland 3, Ohio.

Five years of work on standards for deep well vertical turbine pumps were completed recently by ASA Committee B58, which submitted the final draft to AWWA as sponsoring agency. After passing the regular approval procedure of AWWA, the document goes to the American Standards Assn. for its approval. Eight societies and institutions besides AWWA are represented on the committee, which is headed by Perry H. Brown and Marvin H. Owen as cochairmen. The other AWWA committee members—all of whom deserve recognition and thanks for their labors—are:

W. L. Dornaus
Fenmore Dunn
N. C. Ebaugh
C. R. Erickson
Edward Farmer
A. D. Henderson
H. A. Knudsen
T. R. Mackay
M. S. McIlroy
L. E. Ordelheide
J. L. Perhab
Dan Rankin

When the document has received final approval, the text will be published in the JOURNAL.

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Cheaper Than Water! is the new slogan the Ethyl Corporation is using in its national advertising of the merits of gasoline—cheaper, that is to say in fine print, than distilled water at a service station. Actually, of course, Ethyl didn't have to be that cute about the idea, for, on the basis of producing energy to operate automotive equipment, gasoline is certainly cheaper than drinking water—or even raw water for that matter. All of which must have been pretty obvious to two service station owners in Webster, Mass., last month after each had filled the tanks of a number of cars with plain water. First cost may not have been so high, but the incidental expenses of towing, carburetor cleaning, and customer ill will came to a pretty penny. Cause of it all was a delivery by a distributor from a truck that had been ballasted with water for a return trip and then sent out again before being reloaded. Even in that case, if some of the energy produced by the somewhat superheated motorists could have been harnessed, water might have proved cheaper on the Btu basis as well—which is getting down to the level of thinking that went into Ethyl's tricky slogan.

We were going to suggest that, if you had a copy of the *Saturday Evening Post* or one of the other bigtime magazines around, you might clip the ad and take it and a ten-gallon can of your own product down to your service station to see what kind of a deal you could make. On a gallon-for-gallon basis, after all, you'd be giving your dealer a real break. But, then, why not let Ethyl have her "cheapest" and start pointing out, instead, that water is "more valuable" and deserves a commensurate price. Probably not

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until water is as expensive as gasoline will people realize that it's worth a lot more.

Charles W. Krause, New York district manager of Neptune Meter Co. (right), is succeeding Henry W. Hitzrot of The Dorr Co. as unpaid director of the Water & Sewerage Industry & Utilities Div., Business & Defense Services Administration, Dept. of Commerce. Like his predecessor, T. T. Quigley of Wallace & Tiernan, Inc., in the six-month rotation-service system, Hitzrot will continue to be available to the division on a consultant basis. At left in the photo, administering the oath of office, is BDSA chief Charles F. Honeywell.

W. H. Weir, on leave from the Georgia Div. of Water Pollution Control, of which he is director, is due to return soon from serving as a sanitation consultant for WHO in Formosa, working on problems of water supply.

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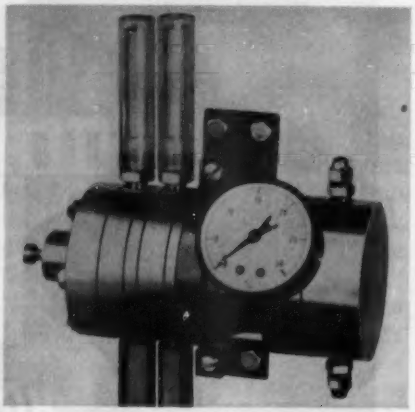
The School of Public Health of the Univ. of North Carolina has contracted with the Inst. of Inter-American Affairs of the US Foreign Operations Administration to strengthen the sanitary engineering educational and research program of Peru's National School of Engineering at Lima. The North Carolina school's Dept. of Sanitary Engineering will administer the expenditure of approximately $185,000 under the contract. Among those faculty members who will go to Peru for varying periods during the first year are Emil T. Chanlett, to work on environmental sanitation; Marvin L. Granstrom, to set up the laboratory of sanitary chemistry and biology; and Daniel A. Okun, to consult on sanitary engineering. Peruvian faculty and engineers will also come to North Carolina for special training.

1954's Title of the Year, aside perhaps from the Sir with which Winston Churchill was dubbed, must have been the one which appeared over the fifth report of the Committee on Subsoils of Boston in the October issue of the *Journal of the Boston Society of Civil Engineers.* "Boring Data From Greater Boston" was what the editors called it, and appropriately, too, for the twenty pages of small type and three tipped-in contour maps were probably as unexciting as they could be useful. As far as we're concerned, if the committee's next report is titled "More Boring Data . . . ," that's impossible.

(Continued on page 42 P&R)

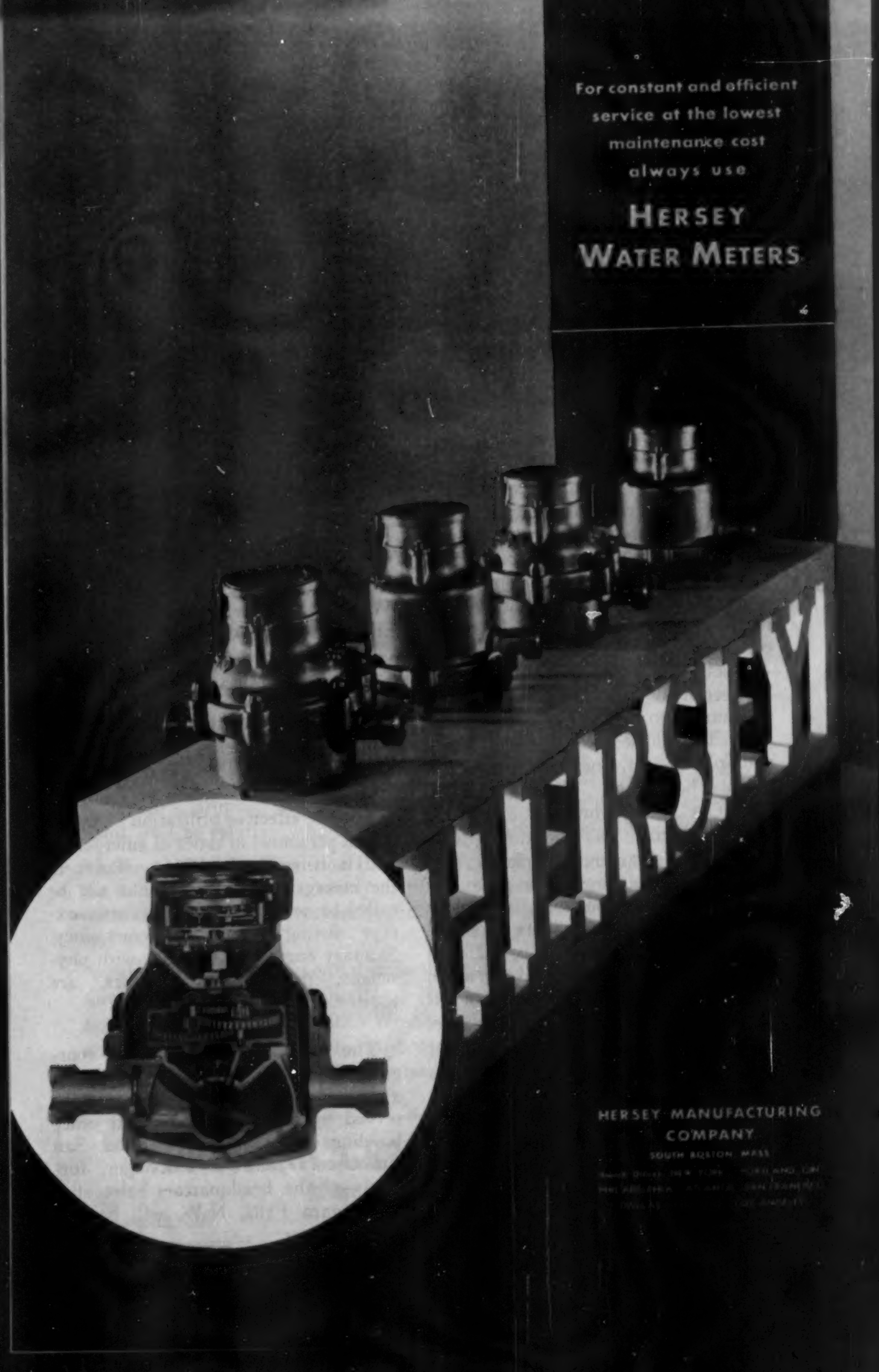
(Continued from page 40 P&R)



A pneumatic transmitter especially designed for water filtration, sewage, and industrial service has been developed by Builders-Providence, Inc., Div. of B–I–F Industries, Inc. The compact Model ATD BalanCel transmitter (shown above) is only 7 in. long and weighs 4 lb. Operating on the force-balance principle, it delivers pneumatic output pressures which vary directly or inversely with changes in loading pressures. It can also be used to add or subtract a second loading pressure, when desired. Small diameter tubing conveys the pneumatic signal between the transmitter and the remote instrument which is to be actuated. With a minimum output of 3 psi, the BalanCel may be used for measuring rate of flow, loss of head, liquid level, and pressures up to 35 psi.

New officers of the Vertical Turbine Pump Assn. include Warren L. Bremer, Layne & Bowler Pump Co., Los Angeles, as president; William H. Reeves, Layne & Bowler, Inc., Memphis, as vice-president; and B. A. Tucker, Peerless Pump Div., Food Machinery & Chemical Corp., Los Angeles, as secretary-treasurer.

(Continued on page 44 P&R)



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HERSEY
HERSEY MANUFACTURING COMPANY
SOUTH BOSTON, MASS.

(Continued from page 42 P&R)

A dog's life these days ain't what it used to be. As a matter of fact, among them, the ASPCA, the new veterinarians, and pwecious women have managed to mangle one of our handiest metaphors, until what once was rued must now be envied. "Sick as a dog" in the new lexicon must mean "in a soft bed in a private room in a swanky hospital with pretty nurses and good television reception, for a slight hangnail," while "dog tired" can only indicate "bored with all the attention."

What brings all this caninity up here is recent evidence that the spoils system is beginning to involve the water works field as well. First sign of this came from Kitchener, Ont., when water superintendent Marcel Pequegnat was hard put to explain to his commission why one of his hydrants was set 40 ft back from the street line between two houses. It turned out, of course, to be a wooden dummy, painted to look like the real thing, and placed for the convenience of neighborhood dogs. Then, from Portland, Ore., came word that one of the local beauticians has had the hydrant outside his shop chrome plated, presumably only to beautify the place, but knowing full well that the kind of dogs owned by the kind of clients he would like wouldn't stop at a drab, old, iron plug. And with housebreaking much too bruising to the personality of today's dog, every pet shop and kennel counter has its stock of mock hydrants for use in teaching little poochies sublimation.

With hydrants the rugged fixtures that they are, this practice is relatively harmless, unless, of course, it happens to happen at your house. But what does worries us is the next step. Who knows how soon good public relations may require rubbing our meter readers' legs with steak sauce to please the pampered pests—pets, that is?

Abel Wolman of Johns Hopkins Univ. has been appointed editor of the *American Journal of Public Health,* official organ of the American Public Health Assn. He succeeds C.-E. A. Winslow, who has retired after serving in that post for 10 years. Prof. Wolman can claim abundant qualifications for his new post on the score of his AWWA experience alone, for he has not only received just about every office and honor that AWWA has to offer, but he also served as editor of this JOURNAL from 1922 to 1937. Raymond S. Patterson will assist Prof. Wolman as associate editor in charge of manuscripts.

The Public Health Service is planning a major expansion of its forces, and expects to commission 2,000 additional reserve officers in the next six months, and a further 3,000 in the following year. The buildup is designed to provide effective utilization of public health personnel in times of emergency, and it is emphasized that officers in the emergency reserve would not be called to active duty involuntarily except during a national emergency. Sanitary engineers, together with physicians, dentists, and nurses, are wanted.

The Carborundum Co. has reorganized its West Coast activities into a new Pacific District, which will be served by new warehouse and office buildings at Los Angeles and San Francisco. John G. Fritzinger, formerly of the headquarters sales staff in Niagara Falls, N.Y., will be district manager.

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L'eau! L'eau! That's the nectar that French Premier Mendes-France is busy proselytizing to his people these days. Down with wine, up with *l'eau* has become the official government position. And if *l'eau* isn't very high as yet, even we, who are rather rabid on the subject, aren't too surprised. After all, the French have been known as winebibbers since France itself was in bibs—which makes for a tradition that even the intrinsic merits of water will need a little time to overcome.

Behind the government's efforts to get Frenchmen to mend their ways, at least during working hours, is the growing apprehension of medical authorities concerning alcoholism as a national problem, and of economists concerning the reduced efficiency and increased accidents traceable to the morning, noon, and night wining that runs the average French workingman's consumption up close to $\frac{3}{4}$ gpd. That's the problem! And where better find a solution than in the universal solvent?

Our waterwise glee, however, doesn't appear very widely shared. "If this mended France of Mendes-France is realized," our French friends say, "our country, she will lose her sparkle." And why not, with its government gone from Vichy to plain water in less than ten years?

A new Geological Survey laboratory is to be established in Albany, N.Y., to serve the six New England states and New York. Felix H. Pauszek, district chemist for the Quality of Water Branch of the survey, will be in charge.

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The Reading Meter

The Industrial Utility of Public Water Supplies in the United States, 1952. *Geological Survey, Washington 25, D.C. (1954).* **Part 1—States East of the Mississippi River.** *Water-Supply Paper 1299, 639 pp.; paperbound, $2.25.* **Part 2—States West of the Mississippi River.** *Water-Supply Paper 1300, 462 pp.; paperbound; $1.75. Order from Government Printing Office, Washington 25, D.C.*

The long-awaited consolidation of the Geological Survey's regional reports on public water supplies has at last been issued, with some new material, in two substantial volumes. Intended primarily to provide data on the chemical quality of public supplies, the reports also give information on the ownership, source, capacity, storage, and treatment process of each utility. Chemical analyses of both raw and finished waters are given. A new feature is the hardness maps showing average hardness throughout the country for raw and finished waters. Unfortunately, these show average ranges for each state as a unit, rather than attempting to follow actual watershed distribution. There are 1,315 larger cities (including all over 15,000 population) with approximately 88,000,000 population covered in the tabulations. Of these, about 52,000,000 are served moderately hard or soft water (100 ppm or less).

Pipe Line Corrosion and Cathodic Protection: *A field manual. Marshall E. Parker. Gulf Pub. Co., Box 2608, Houston 1, Tex. (1954) 102 pp.; $3*

The text of this manual, except for the appendixes, was reprinted from *World Oil* magazine, which ran the twelve chapters serially. Methods of testing soils and protecting pipe under various conditions are outlined, and the operation and maintenance of cathodic protection systems described. Observing properly that corrosion engineering is still an art or possibly technology rather than a science, the author nevertheless attempts to present basic procedures and principles in a systematic way.

National Fire Codes: *IV. Extinguishing Equipment. National Fire Protection Assn., 60 Batterymarch St., Boston 10, Mass. (1954 ed.) 640 pp.; $6*

Volume IV of the new set of six National Fire Codes includes material on water supplies, public and private; valves and their care; and fire pumps, storage tanks, and hydrants. The other volumes in the series are: I. Flammable Liquids and Gases; II. Combustible Solids, Dusts, Chemicals, and Explosives; III. Building Construction and Equipment; V. National Electrical Code; and VI. Transportation. The last is a newcomer to the series.

Dams and Control Works. *Bureau of Reclamation, Denver Federal Center, Denver, Colo. (3rd ed., 1954) 218 pp.; boards; $2.75 from Bureau (Att: 841) or from Government Printing Office, Washington 25, D.C.*

In its third edition this summary of the Bureau of Reclamation's experiences in designing and constructing dams and control works has been simplified and presented in more general fashion. Drawings and photographs illustrate specific installations. A separate chapter on reservoir outlets and spillway gates is included.

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The Reading Meter

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Selected Bibliography of Publications Relating to Undesirable Effects Upon Aquatic Life by Algicides, Insecticides, Weedicides. *William Marcus Ingram & Clarence M. Tarzwell. Pub. 400 (also known as Public Health Bibliography Series No. 13), Public Health Service, Cincinnati 26, Ohio (1954) 28 pp.; paperbound; 15¢ from Government Printing Office, Washington 25, D.C.*

In addition to the bibliographical entries, this publication keys the chemical and organism discussed in each reference, a measure which greatly increases its usefulness. Bioassay toxicity tests occupy a special section of the bibliography.

Summary of Observed Rainfalls on Florida to 31 December 1952. *Water Survey & Research Paper No. 11, Div. of Water Survey & Research, State Board of Conservation, Tallahassee, Fla. (1954) 334 pp.; paperbound*

This report constitutes a revision and addition to Water Survey & Research Paper No. 1, which gave monthly totals from the earliest records to 1947. In addition to giving monthly and annual records for over 400 gaging stations, it includes frequency summaries for those areas where the period of record is long enough to justify them.

Hydraulic Research in the United States: 1954. *Helen K. Middleton, ed. Miscellaneous Pub. 210, National Bureau of Standards, Washington 25, D.C. (1954) 203 pp.; paperbound; $1.25 from Government Printing Office, Washington 25, D.C.*

A successor to Miscellaneous Publications 201, 205, and 208, which dealt with the three previous years, this volume indexes and reviews the hydraulic research projects being conducted by various hydraulic and hydrologic laboratories in the U.S. and Canada. Identification of the projects and published results are given.

(Continued on page 78 P&R)

Independence Hall in front of which old cast iron main still serves.

AMERICA'S OLDEST CAST IRON WATER MAIN TIED IN WITH NEW

The first cast iron water main in America was installed in Philadelphia in 1821. Last year this 133 year old 10″ water main in front of historic Independence Hall was tied in with a modern new 16″ feeder main because the venerable old main was found to be still in good condition.

This illustrates dramatically the permanence and long run economy of cast iron pipe—the best buy for cities anywhere.

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Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH—Bulletin of Hygiene (Great Britain); CA—Chemical Abstracts; Corr.—Corrosion; IM—Institute of Metals (Great Britain); PHEA—Public Health Engineering Abstracts; SIW—Sewage and Industrial Wastes; WPA—Water Pollution Abstracts (Great Britain).*

TASTE AND ODOR

The Influence of Iodides on Intensifying the Odor and Taste Resulting From the Presence of Phenol [in Water]. C. CANDIDO C. & M. M. SANTOS DE N. Anales Bromatol. (Sp.), **4**:349 ('52). Drinking water of Lisbon sometimes has objectionable taste and odor resulting from presence of chlorinated compounds of phenol. Solns. contg. 10^{-8} to 10^{-20} phenol or cresol, plus added KI, were treated with NaClO and NH_4Cl. KI did not impart any odor or taste to H_2O but did intensify phenolic odor and taste of H_2O contg. phenol or cresol treated with NaClO or NH_4Cl. Under these conditions, latter intensified phenolic odor and taste more than former. Odor and taste resulting from added cresol were perceptible at lower concns. than that from added phenol. At higher concns. taste and odor of phenol and cresol could not be distinguished.—*CA*

Destruction of Phenols by Oxidation With Ozone. S. J. NIEGOWSKI. Ind. Eng. Chem., **45**:632 ('53). Usual addn. of Cl to drinking water for germicidal purposes aggravates objectionable odors and tastes caused by minute amts. of phenol. By proper pretreatment, oxidation with O_3 provides economical solution to destruction of phenols in industrial wastes. Most wastes studied required only adjustment in initial pH preceding oxidation process. Refinery or other wastes with high sulfide content may require preaeration for sulfide removal. Toxicity of such wastes can be reduced by destruction of phenols and oxidation of thiocyanate and cyanide. Chem. O demand of these wastes is decreased as treatment process is oxidative.—*CA*

Taste Troubles Overcome at Metropolitan Water Board Works. ANON. Wtr. & Wtr. Eng. (Br.), **56**:231 ('52). New River water is now derived from River Lee at New Gauge and from several wells situated along bank of New River which pump it from underground chalk. On Jan. 19, '52, strong chemical taste was detected in water. As precautionary measure, it was dosed with 20 ppm carbon before filtration. Dose was increased to 40 ppm next day. Despite this procedure, hundreds of complaints of bad tastes were received. By noon on Jan. 20 whole of output from Hornsey works, normally taken from New River, had been replaced by Thames-derived water. All taste disappeared by Jan. 21. In meantime strong-tasting water was cleaned from filter beds at Hornsey, and water at Stoke Newington works, downstream from Hornsey, was treated with activated carbon, with chlorine arrangements varied. As result, water passing into supply from Stoke Newington works was kept free from taste, and filtered water from Hornsey works was free from taste on Jan. 25, when limited quantity was again pumped into supply.—*H. E. Babbitt.*

Taste- and Odor-producing Components in Refinery Gravity Oil Separator Effluents. C. C. RUCHHOFT ET AL. Ind. Eng. Chem., **46**:284 ('54). Organic materials were concentrated from gravity oil separator effluents of 5 petroleum refineries, using carbon filters and countercurrent liquid-liquid extraction. Recovered extracts were examined by means of group separations, fractional distillation, infrared absorption spectrophotometry, chromatography, and organoleptic procedures to determine kinds and quantities of organic materials in petroleum refinery wastes that may give rise to taste and odor in receiving waters used for drinking-water sources. Neutral group, consisting mainly of aliphatic and aromatic hydrocarbons, was found to be principal source of odorous materials in these wastes. Neutral sulfur compounds, associated largely with aromatic materials, add substantially to odor characteristics. Phenolic compounds, second most abundant group in these wastes, are

(*Continued on page 62*)

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significant in problems of taste and odor. Role of acidic and basic materials as contributors to taste and odor in finished water is believed to be less important.—*PHEA*

AQUATIC ORGANISMS

Antialgal Properties of Various Antibiotics. M. J. Foter, C. M. Palmer & T. E. Maloney. Antibiotics & Chemotherapy, **3**: 505 ('53). Antialgal effectiveness of aureomycin, aerosporin, bacitracin, chloromycetin, gliotoxin, neomycin, penicillin, streptomycin, and terramycin was determined for 3 groups of algae, which included 5 blue-green, 5 green, and 3 diatom cultures. Antibiotics were tested by both antibiotic sensitivity disc and serial-dilution methods. Cultures were incubated about 1 month at 22°C, under exposure to approximately 140 ft-candles of artificial light. Sensitivity disc tests indicated that blue-green algae were more sensitive to antibiotics than were green algae or diatoms. Streptomycin inhibited growth of all 13 algal cultures used in sensitivity disc test, while terramycin exhibited activity against 7. Penicillin, bacitracin, chloromycetin, and aureomycin were less active for blue-green algae and displayed little activity against green and none against diatom test cultures. By serial-dilution method in liquid synthetic medium against 6 representative algal cultures, streptomycin and neomycin were most effective in preventing growth. Viability tests conducted on critical inhibitory concentrations indicate that antibiotic action is algicidal under long exposure period employed.—*PHEA*

Algae Control and Methods of Enumeration. S. O. Swartz. Taste & Odor Control J., **20**:1:1 (Jan. '54). Author deals with classification of plankton. Brief description of distinctive physical characteristics, optimum conditions for growth, and types of odors associated with Diatomaceae, Cyanophyceae, Chlorophyceae, Chrysophyceae, Protozoa, Crustacea, Rotifera, and Schizomycetes is presented. Important genera under each class are named and their outstanding characteristics noted. Also included are chart showing classification of plankton and table listing algae frequently found in water supplies.—*PHEA*

Evidence for a Diurnal Pulse in Stream Phytoplankton. J. L. Blum. Science, **119**: 732 ('54). Plankton counts made on 24-hr series of samples collected from Saline R. in Michigan showed diatom *Nitzschia palea* to be more abundant in plankton in afternoon than at dawn. Other chlorophyll-bearing organisms in plankton did not exhibit this diurnal periodicity. Author theorizes that greater availability of light during midday hours, with resultant increased photosynthesis, is mechanism responsible for entrance of large numbers of *N. palea* into plankton. *N. palea* is of benthic origin in Saline R., and production of oxygen bubbles in photosynthesis may increase buoyancy of this bottom algal mass and cause it to rise, break up, and float downstream as plankton. Author concludes that plankton samples taken from areas immediately downstream from benthic communities of unattached unicells, such as community of *N. palea* in Saline R., may give unreliable results if taken at indiscriminate hours.—*PHEA*

Relationship of Aquatic Fungi to Water Pollution. J. V. Harvey. Sew. Ind. Wastes, **24**:1159 ('52). During approximately 1 yr of preliminary study, more than 500 soil or water samples were collected over areas of localized drainage in southwestern Ohio for isolation of specific groups of fungi. Collection stations were selected so as to represent both polluted and nonpolluted sources. Of Saprolegniales, species of *Saprolegnia* and *Achlya* persistently have been absent from heavily polluted water and have seldom been found in partially polluted places; *Dictyuchus* sp. and *Brevilegnia diclina* followed same pattern, as well as Pythiaceae species represented by *Pythium debaryanum*. *Brevilegnia subclavata*, *Geolegnia inflata*, and *G. septisporangia* were not found in contaminated water or soil. Of "true" water molds, only *Aphanomyces* showed some affinity for polluted water. Strains of *Aphanomyces*, *Cephalosporium*, *Trichoderma*, and *Geotrichum* isolated require further study to determine their role in polluted waters.—*PHEA*

Fungi in Polluted Water and Sewage. W. B. Cooke. Sew. Ind. Wastes, **26**:539, 661 ('54). **I. A Survey of the Literature.** 39 books or articles have been found in which fungi or filamentous bacteria have

(Continued on page 64)

Rensselaer Valve with "O" Ring Seal and Ring-Tite Joint.

(Continued from page 62)

been mentioned generally or specifically in connection with sewage or polluted water. These are reviewed chronologically discussing type of work done and giving more important results. **II. Isolation Technique.** Media containing various nutrients for fungi and inhibitors of bacteria are described. These were used in tests designed to develop mold populations of sewage treatment plant, as well as those of other polluted habitats. Most efficient of media tested was modification of Martin's modification of Waksman's soil mold plate count agar. Dextrose, plant protein hydrolysates, and mineral salts comprise basic medium, with rose bengal added for inhibition of bacteria and reduction of colony size of fast spreading molds, and aureomycin added for inhibition of most bacteria present in samples of polluted water and sewage. Techniques and media used are described in detail.—*PHEA*

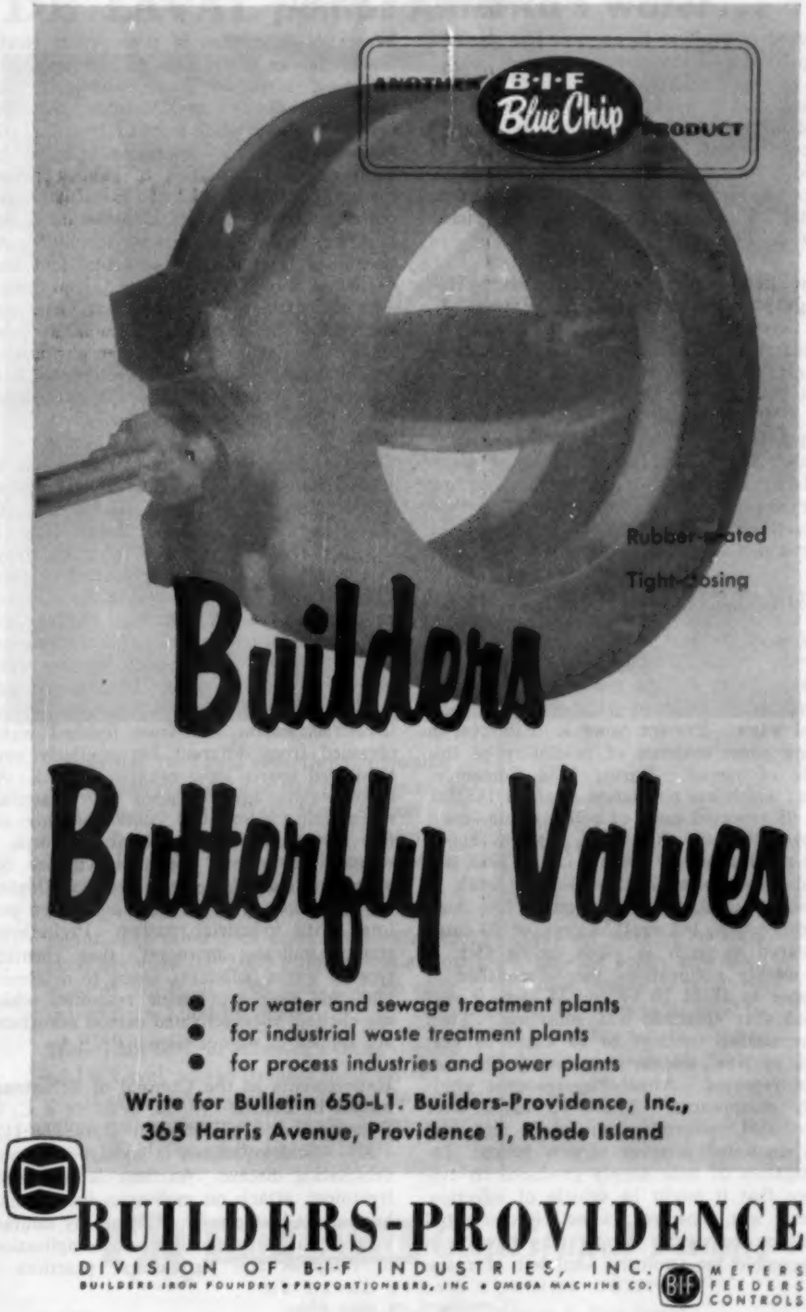
The Use of Antibiotics in Media for the Isolation of Fungi From Polluted Water. W. B. Cooke. Antibiotics & Chemotherapy, **4**:657 ('54). Sets of samples of sewage in various stages of treatment from Dayton, Ohio, sewage treatment plant were surveyed to determine their mold populations. During parts of survey 2 dyes and 4 broad-spectrum antibiotics were compared as to their efficiency in developing these populations with minimum of bacterial contamination. It was found that rose bengal was more effective than closely related dye, phloxine, for this work. It was also found that chlortetracycline (aureomycin) and streptomycin sulfate or dihydrostreptomycin sulfate could be held in aqueous solution over period of at least 3 months under refrigeration, during which time their effectiveness did not appreciably decrease. Oxytetracycline (terramycin) did not decrease in effectiveness over 2-wk period, but it apparently started to change before end of that time. Chloramphenicol (chloromycetin) was not as effective as streptomycin in inhibiting bacteria, possibly because it had lower solubility under conditions of experiment. Medium recommended for enumerating mold populations of polluted water and sewage is basic Waksman soil mold plate count agar, nonacidified, in which phytone or soytone replaces peptone, and which contains 0.035 g/l rose bengal and 35 μg/ml chlortetracycline in aqueous solution. Oxytetracycline (terramycin) may be used if it is made up fresh for each experiment or if it is held in aqueous solution for only few days.—*PHEA*

HYDROLOGY

Stratification and Overturn in Lakes and Reservoirs. R. W. Thompson. J. Inst. Wtr. Engrs. (Br.), **8**:19 ('54). Stratification leads to differences in chemical content and biological character, and has been observed in small, as well as large, depths of water. Duration varies with depth, being greater for larger depths. Thermal stratification is primarily due to physical properties of water. 3 layers are observed: [1] upper or epilimnion (high and fairly uniform temperature); [2] thermocline (temperature decreases rapidly with depth); and [3] lower or hypolimnion (low and fairly uniform temperature). This is typical pattern—some variations are described. Author gives description of typical annual cycle, outlining seasonal changes occurring. Variations which can occur are listed; some of these exert steady, and others erratic, influences on stratification. Following this introduction is section dealing with stratification in specific impounding and storage reservoirs. There is detailed description of points of measurement, method of measurement, and results from named reservoirs, and number of interesting conclusions are drawn. Little appears to be known about action of wind, but author believes it to be factor hardly less important than temperature in determining internal behavior of lake or reservoir. Reference made to most modern methods of measuring subsurface temperatures, i.e., by electrical means. Article concludes with short account of reservoir outlets and biological control. Author emphasizes desirability not merely of providing outlet at very bottom of reservoir, but also of making it of sufficiently large capacity and with adequate arrangements for dispersal of energy.—*PHEA*

The Water Requirements of Plants. H. L. Penman. Wtr. & Wtr. Eng. (Br.), **57**: 239 ('53). Transpiration as physical process is one over which plant has little control. Transpiration from green crop was found to be about 80 per cent of that from open water surface, and type of crop did not seem to have appreciable effect on transpiration rate.

(Continued on page 66)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(Continued from page 64)

Marked controlling factor was root system; deep roots gave steady rate over long period. Of energy reaching plot in form of solar radiation, 1% used for plant growth; 2% used for soil heating; 4% used for heating air; 20% lost by reflection; 24% lost by back radiation; and 39% lost by transpiration. By irrigation, plant growth can be controlled and aided to give increased yields. —*H. E. Babbitt*

Simplified Method for Preliminary Hydrographic Surveys of Calm Waters. R. D. SCHACHERL. Civ. Eng., **23**:316 ('53). Economical and simple method of approximately locating points, such as positions of boat during soundings, on calm waters is use of transit or plane table set up as high as possible above water level. Percentage error may be kept very low when water surface is calm and instruments reading vertical angles less than 1′ are used. Method is particularly advantageous for use on lake surrounded by hills or mountains.—*PHEA*

HEALTH AND HYGIENE

Poliomyelitis and Water Supply. G. M. LITTLE. Can. J. Pub. Health, **45**:3:100 ('54). There is little published evidence of actual transmission of poliomyelitis by polluted water. Present paper is of interest in giving some evidence of possibility of this mode of spread. During 1952 Edmonton, Alta., which has population of about 183,000, had 95 reported cases of poliomyelitis—most severe incidence since 1927. It was hoped that number of cases would fall in 1953, but incidence rose to 322 cases. Peak week in previous years had always been in late Aug. or early Sep., but in 1953 peak of 20 cases appeared to occur in week ending Oct. 3. As weekly notifications then diminished in number to about 10 by end of Oct., it was hoped that epidemic was subsiding. Then came sudden upsurge of 37 cases in first week of Nov., and in second week 38 cases were reported. After this, epidemic gradually disappeared. These 75 cases were distributed uniformly over whole city, and this suggested presence of new factor. Investigation of milk supply produced no evidence that it might be vehicle of infection. There was, however, some circumstantial evidence that water supply may have been responsible for explosive outburst of cases. Water of Edmonton is taken from North Saskatchewan R. and is purified by settlement, softening, filtration, and chlorination. 20 miles above intake at Edmonton, river receives sewage of small town of Devon (1,600 population). This sewage is treated by settling and chlorination of effluent before discharge into river, but at time of explosive outburst of poliomyelitis, chlorinating equipment in Devon was "giving trouble." As there had been number of actual and suspected cases of poliomyelitis in Devon during Sep. and Oct., it is possible that virus was transmitted by sewage to Edmonton water supply. Usual method of water purification in Edmonton might be ineffective, as it is doubtful if ordinary chlorination levels inactivate virus of poliomyelitis.—*BH*

Carcinogenic Studies on Adsorbates of Industrially Polluted Raw and Finished Water Supplies. W. C. HUEPER & C. C. RUCHHOFT. AMA Arch. Indus. Hyg. & Occupational Med., **9**:488 ('54). Bioassays of 4 eluates of carbon adsorbates of raw and finished surface water supplies for carcinogenic properties showed that eluates prepared from raw water polluted with oil refinery effluent were weakly positive when painted on skin of mice. Eluates prepared from raw river water polluted by various industrial wastes and from finished water obtained from different but similarly contaminated source gave negative results. As these results were obtained with materials representing adsorbates containing any active agents in highly concentrated form, it remains at present uncertain whether observations made have any direct application to population groups consuming water polluted with industrial wastes. Preliminary studies indicate, moreover, that chemical type of water pollutants seems to determine kind and degree of tissue responses which are elicited when activated carbon adsorbates are applied to skin of mice.—*PHEA*

Experiments in the Control of Schistosomiasis in Brazil. W. H. WRIGHT & C. G. DOBROVOLNY. Pub. Health Rpts., **68**:1156 ('53). Schistosomiasis is widely distributed debilitating disease. As there is no specific treatment, attack on molluscan intermediate host offers best results. Control by sanitary measures is impractical due to complications of religious and agricultural practices in

(Continued on page 68)

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many infected areas. Many chemicals were screened against *Australorbis glabratus*, followed by field trials of most promising. Study established in Brazil, between 5 and 15 deg south of equator, employed quiet bodies of water. Chemicals were applied by sprayer or as dust at rate of 10 ppm or less, and were found to be effective 1,000 ft below site of application. Of 33 compounds tested, sodium pentachlorophenate applied at 10 ppm was most effective. Thus used, no snails were found in 11 of 28 streams in first month following treatment, but most were repopulated within 4 months. Results indicate that control of snails can be obtained, at relatively low cost, with treatments at intervals of 3–4 months, that eradication cannot be accomplished in 1 yr, and that techniques of application may necessarily vary with different geographical areas.—*PHEA*

The Bacteriological Examination of Water Samples From Houses of Cases and Contacts of Typhoid Fever and Dysentery and From Public Eating Places. A. P. de Roda & R. S. Ana. J. Philippine Med. Assn., **29**:7:346 ('53). Bacteriological quality of water supplied by Metropolitan Water Dist. to city of Manila can be considered highly satisfactory and cannot be held responsible for transmission of pathogenic intestinal organisms. Beginning in 1947 samples of drinking water were collected from containers in houses where there was no piped supply, from taps in other houses where piped supply existed, and from such public eating places as restaurants, hotels, and markets. Collections were limited to houses and other buildings where cases of typhoid fever or dysentery had occurred or where there were contacts of such cases. Samples were submitted to bacteriological tests, consisting of plate counts after incubation for 24 hr at 37°C and isolation of coliform organisms by preliminary enrichment in BGB and confirmation on EMB agar. Potable water was considered as one with no more than 100 colonies per ml and negative with regard to coliform test in similar volume. In all, 499 samples were collected from house containers, 358 from taps in houses, and 1,432 from bottles and pitchers in public eating places. Bacteriological findings showed that only 25% of samples collected from house containers and only 76% of samples collected from taps in houses could be considered of satisfactory hygienic quality. In public eating places, 88% of drinking-water samples were found to be potable. Therefore, in spite of excellent sanitary quality of water supply of city, insanitary conditions and practices prevailing do not eliminate possibility that drinking water in Manila still remains constant danger to public health. It remains factor in endemicity and occasional outbreaks of enteric infections. Provision of water services to every house should be extended, and public educated in handling of drinking water. Use of questionable containers both for houses and public eating places should be discouraged. Residual chlorine of water should be determined, and water in distribution system examined frequently for bacteria. Any areas of negative pressure in water lines should be remedied and proper disinfection of pipes carried out when replacing or extending services.—*PHEA*

DISINFECTION

Bacteriological Study of Chlorine Action in Water Treatment. L. Popp. Gas- u. Wasserfach, **95**:100 ('54). When bacteria-containing water is treated with Cl, part of bacteria killed in short time, percentage killed depending on excess Cl over that required to react with bacteria and organic matter; remaining bacteria killed at much slower rate. Free available Cl is best determined by using waiting time of only 30 sec (rather than 5 min) for H-Cl-*o*-tolidine test. Available Cl determined after 5 min also includes available combined Cl. Activity of excess free Cl appears to decrease after water has stood for some time, even in absence of bacteria and even though *o*-tolidine test shows appreciable free Cl content. Bactericidal action of Cl is greatest at low pH values, which would appear to indicate that active agent in freshly prepared Cl water is mainly mol. HOCl. Ionizing action ($HOCl \rightarrow H^+ + OCl^-$) may be responsible for loss of bactericidal activity with time. Very low Cl dosages, such as 0.2 mg/l of water, are unsafe, as there is insufficient reserve to handle increases in number of bacteria or organic-matter content. Sufficient Cl should be used to assure high-percentage kill during first rapid stage.—*CA*

(Continued on page 70)

(Continued from page 68)

Elemental Iodine as a Disinfectant for Drinking Water. S. L. Chang & J. C. Morris. Ind. Eng. Chem., **45**:1009 ('53). Germicidal efficiency to determine usefulness of elemental iodine as emergency disinfectant for drinking water. Iodine concentrations of 5–10 ppm have been found effective against all types of waterborne pathogenic organisms—including enteric bacteria, amebic cysts, cercariae, leptospira, and viruses—within 10 min at room temperature. High germicidal activity is maintained over pH range 3–8 in presence of variety of water contaminants. Waters with high organic color may exhibit sufficient iodine demand to require increased dosage for satisfactory disinfection. At low temperatures, germicidal action is slowed, so that contact time of 20 min is required in near-freezing waters. Iodine has number of advantages as emergency disinfectant for water supplies, compared with hypochlorites or chloramines. Its germicidal action is less dependent on pH, temperature, and time of contact; nitrogenous impurities do not impair its effectiveness; and side reactions leading to consumption of germicide are less marked for iodine than for chlorinous disinfectants. Almost all waters can be made safe for drinking with single dose of iodine of approximately 8 ppm.—*PHEA*

Disinfection of Drinking Water Under Field Conditions. J. C. Morris et al. Ind. Eng. Chem., **45**:1013 ('53). In order to utilize effectively excellent germicidal properties of iodine for emergency disinfection of water supplies, rapidly soluble tablet preparations were needed that would consistently furnish 5–10 ppm of elemental iodine when dissolved in water. Tablet compositions containing appropriate amounts of stable, water-soluble polyiodides most nearly possess that combination of properties desirable in emergency water disinfectant. Of numerous compositions tested, tablets containing 20 mg of tetraglycine hydroperiodide, 90 mg of disodium dihydrogen pyrophosphate, and 5 mg of talc were found to be most suitable. Such tablets will dissolve in less than 1 min at room temperature, liberating 8 mg of elemental iodine per tablet, quantity that will satisfactorily treat 1 l of most natural waters within 10 min. Treated water is palatable. Tablets, when packaged properly, are stable for extended periods of storage, even under adverse climatic conditions.—*PHEA*

Service Lines

Rockwell products for sewage disposal plants are described in a 20-page booklet, Bul. C-5200, available from the Meter & Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. Meters and regulators for sewage gas are featured.

A new quarterly, the "Wheelabrator Tips," has been issued for the benefit of users of airless blast cleaning equipment of American Wheelabrator & Equipment Corp. Copies are available from the company at Mishawaka, Ind.

A submersible pump for small water systems has just been developed by Peerless Pump Div., Food Machinery & Chem. Corp., 301 W. Ave. 26, Los Angeles 31, Calif., and is described in Bul. B2455. Available in $\frac{1}{2}$-, $\frac{3}{4}$-, and 1-hp models, the pump is designed for settings as deep as 280 ft, and will produce a maximum of 940 gph from lesser depths.

Grinding wheels for use on tool and die steels are the subject of a folder and selection chart distributed by The Carborundum Co., Niagara Falls, N.Y. Ask for "V40 for Tool Room Grinding."

Polyethylene ware for laboratories is described in the "Polyethylene Catalog" of Palo Lab. Supplies, Inc., 81 Reade St., New York 7, N.Y. Beakers, bottles, and buckets are among the products listed.

"Cooling Water" is the title of a folder on the conditioning of water for cooling systems against scale, corrosion, improper pH, and organic fouling. Available from Hall Labs., Inc., Hagan Bldg., Pittsburgh 30, Pa.


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(Continued from page 46 P&R)

The raw material supply for Transite pipe and other asbestos-cement products is being aided by the opening in Southern Rhodesia of two new asbestos mines and a central mill. The mining and milling of ore is an operation of Rhodesian Asbestos Ltd. under the direction of Canadian Johns-Manville Co., Ltd., in association with British Metals Corp., Ltd., Anglo-Huronian Ltd., and the Simon I. Patino interests. A. R. Fisher, president of Johns-Manville Corp. and Rhodesian Asbestos Ltd., is now in Mashaba, Southern Rhodesia, to superintend the operation. Capacity of the new mill is 125 tons of ore per hour.

C. G. Stupp, technical director of Barrett Div., Allied Chemical & Dye Corp., has been appointed vice-president. A Barrett employee for the past 38 years, he will continue to head the division's technical activities, including the research and development laboratories at Edgewater, N.J.; Glenolden, Pa.; and Toledo, Ohio.

Ernest Cochran, executive vice president of Chapman Valve Mfg. Co., has been elected president and general manager, succeeding the late John J. Duggan. He has been connected with the firm since 1916.

Adams-Massey Well Drillers of Carrollton, Ga., has been appointed distributor of the complete line of drilling muds of H. C. Spinks Clay Co., Paris, Tenn.

(Continued on page 74 P&R)

Atlanta engineers, Wiedeman and Singleton, <u>*again specify*</u>

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(Continued from page 72 P&R)

The cold, cruel world does have a heart after all, and who better to discover it than a novelist—well, rediscover it anyway? Actually, the discovery was made quite some time ago by that genius of all trades, Leonardo da Vinci, who, having noted that springs can be found high on mountain slopes, was moved to deduce: "The body of earth resembles that of a man, and the same cause that keeps the blood at the top of a man's head keeps water at the summit of mountains, whence it flows back again through rivers and returns to the sea." The novelist, of course, could be no less an imaginer than our dowsy friend Kenneth Roberts to have seen so quickly in the heart of this theory the verification of his own at least unorthodox convictions concerning the occurrence of underground water in upward-gushing channels, called veins and pipes, to combine into domes just waiting to be pointed out by the telesthetic twig of his protege pulse-taker, Henry Gross.

"Leonardo da Vinci was a great man," Roberts points out. "Scientists in most fields took advantage of Leonardo's thinking in other fields, developing bombing planes, poison gas, tanks, gas masks, and submarines just as he outlined them in his studies of offensive and defensive warfare. . . . [Why, then, should] geologists condemn his thought about springs and upward rising water as being sheer idiocy"? Although "idiocy" sounds a little more novelistic than it does geologic, we still have an idea that even the most stubborn of geologicians will be willing to apply it to themselves if Ken and his redoubtable dowser manage to put a finger on the terrestrial ticker that keeps the juice flowing through the water vessels of the earth. As a matter of fact, given the right kind of proof, they might even hop aboard Ken's hydrologic bicycle, which gives the earth's liquid center as the source of our underground water and relegates to precipitation the provision of our surface supplies.

Only proof to date, though, has been of the type provided in Roberts' two dowsing best sellers—the 1954 testimony, for instance, of Bishop William Scarlett of Missouri and the Maine Maritime Academy concerning the finding of water on their properties at Castine, Me.; the report of Gross success in discovering hilltop and other supplies for the town of Greenville, N.H., or for the school board of Litchfield, Conn., or for RCA's plant at Bridgewater, N.J., or for Sylvania Electric's headquarters in Woburn, Mass., or for Wayside Gardens nursery at Mentor, Ohio, or even for C. D. Jackson, a former vice-president of *Time* and publisher of *Fortune* at Lenox, Mass. This kind of proof, of course, figuratively, as well as literally, grows on trees, its dowser-deliverers ranging from an aging Charlie Decker of West Milford, N.J., whose album of sworn testimony covers more than 25 years of twig twitching, to an eleven-year-old Carol Terbush of Onida, S.D., whose two-year list of satisfied customers includes her state's Dept. of Game, Fish, and Parks.

All of these often say water is where it isn't, or isn't where it is, but such errors have yet to damage their perfect records. The explanation, of course, is that conditions aren't often entirely favorable and digging or drilling is rarely done properly, or, putting it another way, we really are a subpar golfer though we have a hard time breaking 100 because of the peb-

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bles on the greens, the hard fairways, the rocks in the traps, the partners who make noise at the top of our back-swing, the caddies who pick the wrong clubs, and that gust of wind that always springs up at the inopportune moment. Come to think of it, it's still a cold, cruel, heartless world, and what a golfer Ken would make!

An educational exhibit of basic industrial machinery has been opened to the public by Worthington Corp. at 99 Park Ave., New York. Models of engines and generating equipment which the visitor can operate himself demonstrate the application of physical and engineering principles to common types of industrial machinery. Among the rest are demonstrations of pumps, internal combustion engines, and electric generation.

E. George Baker has been appointed assistant sales manager of the Los Angeles plant of Mueller Co. His duties will include the supervision of all sales personnel at that location.

A glass sealing compound long used in automotive and aircraft servicing is claimed to prolong the life of both rubber and composition gaskets used in water meters, or even to replace the gasket itself. The glass sealer, made by Permatex Co., Inc., Brooklyn 35, N.Y., is said to make the meter register glass watertight and dustproof.

DuBois-Webb Co. of 19951 James Couzens Highway, Detroit, has been appointed representative for Hungerford & Terry, Inc., in the lower Michigan area.

The Reading Meter

(Continued from page 50 P&R)

American Standard Graphical Symbols for Electrical Diagrams—Y32.2-1954. *American Standards Assn., Inc., 70 E. 45th St., New York 17, N.Y. (1954) 58 pp.; paperbound; $1.25*

The American Inst. of Electrical Engrs. and the American Society of Mechanical Engrs. have combined to cosponsor this document. Robert E. Stiemke was the AWWA representative to the committee.

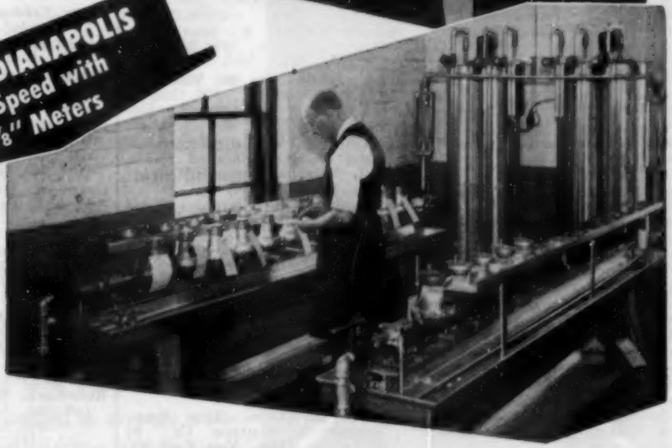
Streams, Lakes, Ponds. *Robert E. Coker. Univ. of North Carolina Press, Chapel Hill, N.C. (1954) 327 pp.; $6*

This book is at once a primer of limnology and fresh-water ecology, a discussion of common pond biology, and an argument in favor of adopting the fish pond into our regular agricultural pattern as an instrument of food production.

In the course of his work, the author discusses some of the physical and chemical aspects of fresh-water bodies, and the pollution and self-purification sequence.

Water Hammer: *Its cause, magnitude, prevenstion. Oscar G. Goldman. Columbia Graphs, Columbia, Conn. (1953) 116 pp.; $5*

This analysis is based upon the author's theory that the hydraulics of water hammer is best explained by considering water as a compressible medium, and therefore elastic. The contention is buttressed by equations, graphs, and the working-out of typical problems.



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Bauerlein, Charles R., Field Engr., Fischer & Porter Co., 29 Bala Ave., Bala-Cynwyd, Pa. (Oct. '54) *P*

Beecher, Jess Stanley, Chief Chemist, Power Chems. Div., E. F. Drew & Co., Inc., 15 E. 26th St., New York 10, N. Y. (Oct. '54) *P*

Berger, Manfred, Purif. Engr., Old Dominion Water Co., Hopewell, Va. (Oct. '54) *MP*

Bideaux, Richard F., Supt., Water Works, West Burlington, Iowa (Oct. '54) *MD*

Bissell, Philip W., Sales Repr., Thompson Pipe & Steel Co., 3001 Larimer St., Denver, Colo. (Oct. '54) *D*

Browne, W. Jack, Supt., Water Works, Avon, N. Y. (Oct. '54) *P*

Buettner, Carl F., Project Engr., City of St. Louis, Water Div., 5461 Tholozan Ave., St. Louis, Mo. (Oct. '54) *M*

Burba, Foster S., Operating Engr., General Waterworks Corp., Inc., Pine Bluff, Ark. (Oct. '54)

Burnet, John W., Resident Field Engr., Ford Motor Co. Canada Ltd., Oakville, Ont. (Oct. '54)

Burton, J. A.; *see* Grand Junction (Colo.)

Caldwell, Dave L.; *see* Rainbow Munic. Water Dist.

Clark, John L., Chief Operator, Water Purif. Plant, 901 Magnolia Dr., Quincy, Fla. (Oct. '54)

Cookus, Glade L., Supt., Palos Verdes Water Co., 78 Malaga Cove Plaza, Palos Verdes Estates, Calif. (Oct. '54) *MD*

Cushing, Russell L., Asst. Supt., Water Dept., Ormond Beach, Fla. (Oct. '54)

Dardel, Walter, Cons. San. Engr., Aarberg (Ct. Berne), Switzerland (Oct. '54) *P*

Dehner, John, Pres., John Dehner Inc., 1206 Clark St., Fort Wayne, Ind. (Oct. '54) *D*

Earls, Ronald E., Operator, Water Works, 163 Oneida St., St. Augustine, Fla. (Oct. '54) *P*

Edwards, Valdemar E., Jr., Comr. of Public Works, Bridgeton, N.J. (Oct. '54) *MRPD*

Farmer, William C., Gen. Supt., Mackle Co. Inc., 2818 Coral Way, Miami, Fla. (Oct. '54) *MRPD*

Fee, J. Kenneth, Sr. Engr., Public Utilities Com., Box 24, Kingston, Ont. (Oct. '54) *PD*

Foreman, Hugh H.; *see* Santa Ana (Calif.) Water Dept.

Gering, Merland D., City Supt., Le Sueur, Minn. (Oct. '54) *MRP*

Gordon, Paul, Asst. Supt., Water Dept., Rochester, Ind. (Oct. '54) *MPD*

Grand Junction, City of, J. A. Burton, City Engr., Box 510, Grand Junction, Colo. (Corp. M. Oct. '54)

Greenwood, Gilbert F., Sr. Civ. Engr., Div. of Water Supply, 125 Smith St., Flint, Mich. (Oct. '54) *RD*

Hanson, E. C., City Mgr., Clarion, Iowa (Oct. '54) *MPD*

Hedrick, Nash J., Salesman, Johns-Manville Corp., Box 1211, Tampa, Fla. (Oct. '54) *D*

Hillman, Fred W., Assoc. Engr., Metropolitan Water Dist. of Southern California, 306 W. 3rd St., Los Angeles 13, Calif. (Oct. '54) *MRPD*

Hourd, Wilbert R., Sales Repr., Crane Co. Ltd., 93 Lombard, Winnipeg, Man. (Oct. '54) *MRP*

Jenson, Theodore B., Vice-Pres., Gee & Jenson, Inc., 309 Comeau Bldg., West Palm Beach, Fla. (Oct. '54) *MRP*

Johnson, C. R., Lab. Technician, Water Works, Purification Plants, 1210 Hemphill Ave., N.W., Atlanta, Ga. (Oct. '54) *P*

Johnson, Robert Allen, Project Engr., R. B. Carter Sales of Florida, Inc., Research & Development Div., 351 Sevila Ave., Coral Gables, Fla. (Oct. '54) *P*

Keck, William G., Consultant, Box 107, East Lansing, Mich. (Oct. '54) *R*

Kendall, George A.; *see* Palos Verdes (Calif.) Water Co.

Kroon, Richard J., Water Supt., Sioux Center, Iowa (Oct. '54) *MRP*

Krout, H. Leon, Sales Repr., Keasbey & Mattison Co., 30 Rockefeller Plaza, New York 20, N.Y. (Oct. '54) *D*

Lebow, Arnold, Chem. Aid, Filter Plant, Water Dept., Water Works Park, Detroit, Mich. (Oct. '54) *P*

Marklund, W. F., Distr. Supervisor, Div. of Water Supply, 125 Smith St., Flint, Mich. (Oct. '54) *D*

May, E. Russell, Mech. Engr., Lacy, Atherton & Davis, Hotel Sterling, Wilkes-Barre, Pa. (Oct. '54) *PD*

McAllister, Gregory T., Vice-Pres., Siliphane Corp. of America, 10 E. 40th St., New York 16, N.Y. (Oct. '54)

McClure, Alex, Sales Engr., Koppers Products Ltd., 10128—103rd St., 202 Barry Bldg., Edmonton, Alta. (Oct. '54)

Miller, Horace G., Asst. Supt., Water Dept., Charlottesville, Va. (Oct. '54) *D*

Miller, Kenneth F., Design Engr., American Pipe & Construction Co., 4635 Firestone Blvd., South Gate, Calif. (Oct. '54) *D*

Minner, Lester A., Asst. Civ. Engr., Albert A. Webb Assocs., 3788 McCray St., Riverside, Calif. (Oct. '54) *RD*

Morris, Robert M., Project Engr., Swindell-Dressler Corp., Box 1888, Pittsburgh 30, Pa. (Oct. '54)

Nolan, John W., Water Supt., West Side Greenwood Lake Water Dist., Town of Warwick, Greenwood Lake, N.Y. (Oct. '54) *MRP*

Nollenberger, Charles G., Asst. Secy., Palos Verdes Water Co., 78 Malaga Cove Plaza, Palos Verdes Estates, Calif. (Oct. '54) *M*

Norris, C. F., Field Engr., Fischer & Porter (Canada) Ltd., 997 Decarie Blvd., Montreal, Que. (July '54)

Oelberg, Emil, San. Engr., Water Safety Control Sec., 3300 E. Cheltenham Pl., Chicago, Ill. (Oct. '54)

Ohrt, Frederick, Cons. Engr. & Trustee, The Estate of James Campbell, 97 Merchant St., Honolulu 13, Hawaii (Oct. '54) *MR*

Palos Verdes Water Co., George A. Kendall, Pres., 78 Malaga Cove Plaza, Palos Verdes Estates, Calif. (Corp. M. Oct. '54) *MRPD*

Plumb, George W., Office Engr., Water Com., Box 904, Medford, Ore. (Oct. '54)

Potts, Thomas B., Outside Supt., Water Works Dept., Public Utilities Com., Box 24, Kingston, Ont. (Oct. '54) *D*

Rainbow Munic. Water Dist., Dave L. Caldwell, Director, 1244 S. Main St., Fallbrook, Calif. (Corp. M. Oct. '54) *D*

Randolph, Bernard E., Resident Inspector, Philpott, Ross & Saarinen, Fort Lauderdale, Fla. (Oct. '54) *MRPD*

Robertson, James C., Jr., Chief, Section Project Eng., Dept. of San. Eng., Dist. Govt., 14th & E Sts., N.W., Washington, D.C. (Oct. '54)

Rohrbach, Harry L., Sales Engr., Lakeside Eng. Corp., 123 E. Woodland Ave., Fort Wayne, Ind. (Oct. '54)

Rowell, Martin, Supt., Water Dept., Westport, Wash. (Oct. '54) *M*

Russo, Vincent, Salesman, Allied Equipment & Supply Co., 691 Broadway, Bayonne, N.J. (Oct. '54) *PD*

Santa Ana Water Dept., Hugh H. Foreman, Acting Director of Public Works, 217 N. Main St., Santa Ana, Calif. (Corp. M. Oct. '54) *MD*

Saunders, Frederick H., Supt., Water Purif. Plant, Public Utilities Com., King St. W., Kingston, Ont. (Oct. '54) *MP*

Skaar, Ralph H., Tech. Repr., Westvaco Mineral Products Div., 161 E. 42nd St., New York 17, N.Y. (Oct. '54) *P*

Sponsler, Richard C., Salesman, Mueller Co., 4631 Manordene Rd., Baltimore 29, Md. (Oct. '54)

Starr, Richard W., Jr., Regional San. Engr., State Board of Health, Indian River County Health Dept., Vero Beach, Fla. (Oct. '54)

Taylor, Robert Louis, Asst. Civ. Engr., Albert A. Webb Assocs., 3788 McCray St., Riverside, Calif. (Oct. '54) *RD*

Section Meetings

Missouri Section: The ninth annual meeting of the Missouri Section was held in Jefferson City at the Hotel Governor, Sep. 26–28, 1954. A total of 260 members and guests were registered. The meeting was held jointly with the Missouri Water and Sewerage Conference, as has been the practice for the past several years.

The program for the afternoons was divided into two sections; one program designed chiefly for operators and the other for management. The subject matter for the operators' program consisted chiefly of round-table discussions of problems pertinent to water plant maintenance and operation. Time was allowed for operators to present their specific problems and have them discussed at length. The managers' section was more administrative, dealing with such subjects as accounting principles and systems, keeping adequate records, handling customers' complaints, air conditioning, and what goes into the cost of production and delivery of water. The topic of fostering water works careers was discussed by John H. Murdoch (*see* December issue, p. 1181).

Life Membership certificates were presented to W. Victor Weir, president, St. Louis County Water Co., and Thomas J. Skinker, water commissioner, St. Louis. The Fuller Award Committee named William B. Schworm of the St. Louis Water Dept. to receive the 1955 Fuller Award of the Section. Frank C. Amsbary Jr., AWWA vice-president, gave a constructive report on some of the Association's policies and activities.

The following officers were elected for the ensuing year: Vance C. Lischer, chairman; Edward Lee, vice-chairman; Warren A. Kramer, secretary-treasurer; and Herbert O. Hartung, director.

WARREN A. KRAMER,
Secretary-Treasurer

Chesapeake Section: The 38th meeting of the Chesapeake Section was held at Baltimore on Oct. 27–29. Guests and members assembled at the Sheraton-Belvedere Hotel, and the usual "Get Together" was held in the Assembly Room the first evening. Thanks to the splendid work of the local arrangement committee headed by Edward S. Hopkins, and the courtesies of the Water & Sewage Works Manufacturers Assn., about 100 preregistered persons had an enjoyable social evening.

The final attendance reached 210, including 27 registered ladies.

A panel discussion on "Upflow Coagulation Basins," led by R. W. Haywood Jr., included statements by Roy Dragone of The Dorr Co., A. A. Kalinske of Infilco, J. S. Kneale of Permutit Co., and Harry N. Lowe from the Research Board, Ft. Belvoir, Va. A. Lieberman of the Atomic Energy Commission discussed "Atomic Waste and Water Supply." Norman Jackson, sanitary engineer of the US Corps of Engineers, presented a discussion on "High Filter Rates" as experienced recently at the Dalecarlia Plant, Washington, D.C., with special emphasis on its effects on quality of effluent.

Thursday afternoon a paper on "Small Plant Water Supply Operating Problems" was presented by Holmes Orgain of the Maryland Health Dept. A panel on

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Section Meetings

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"Financing Water Works Extensions," with Roy Ritter as moderator, included Charles B. Wheeler of Baltimore County Metropolitan Dist., Alfred Machis of Washington Suburban Sanitary Dist., and W. Compton Wills of Wilmington, Del. Donald H. Goldsborough then discusssed "Water Main Failures in the Baltimore Water Supply."

At the business meeting, the following new officers were elected: John C. Tracey, chairman; Bernard L. Werner, vice-chairman; Carl J. Lauter, secretary-treasurer, and, as trustees, John C. Smith, Philip Cooper, and Albert C. Kaltenbach.

Friday morning a film, "Must It Rust?" was shown by Southern Galvanizing Co., Baltimore. Ludwig Adams of the Pittsburgh-Des Moines Steel Co. appropriately enough then discussed "Applied Coatings for Water Storage Tanks." Albert Stevenson of the Civil Defense Administration summarized research work on "Effects of Biological and Chemical Warfare on Water Supplies," after which he read a second paper on "Matching Funds Program" prepared by A. S. Nesheim of the same office. Jerome B. Wolff of the Langley Construction Co., Baltimore, spoke on "Distribution System Deficiencies." A report on public relations was given by E. K. Stabler of Washington Suburban Sanitary Dist., and R. C. Willson, superintendent of the Hagerstown Water Dept., discussed the need to reimburse water utilities for necessitating relocation of their mains.

Friday afternoon trips were made to several points of interest in the Baltimore area: the Liberty Dam, the New Park Terminal Operating headquarters, and the Ashburton Filter Plant now under construction for Baltimore.

On Thursday after the business sessions the manufacturers provided a very

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Section Meetings

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pleasant social hour for the members and guest, and the usual annual banquet was held in the ballroom of the Belvedere. Life Membership certificates were presented to P. O. Macqueen, Byron Bird, Arthur E. Gorman, and Walter S. Munroe by AWWA vice-president Frank C. Amsbary Jr. The Fuller Award nomination went to George L. Hall, chief engineer of the Maryland Dept. of Health.

C. J. Lauter
Secretary-Treasurer

California Section: The 35th annual conference of the California Section, held at Long Beach Oct. 26–29 registered the largest attendance of any conference ever held in California, including the national convention in San Francisco in 1947. Attended by 1,709 persons, the conference was outstanding for its capable planning and fine hospitality.

Exceeding all previous records, the exhibits in the Long Beach Municipal Auditorium occupied 74 booths arranged by 57 exhibitors. The golf tournament teed off with 106 men and 16 women—believed to be the largest group of water works golfers to tee off at any conference, including the national conventions. The dinner on Friday night was served to 1,150 persons with excellent entertainment provided and dancing until after midnight.

Interest in the conference and its large attendance can be principally credited to the technical program arranged by Louis J. Alexander and to the smooth-running cooperation among the various members and committees of the California Section and the representatives of the Water & Sewage Works Manufacturers Assn. In addition, the work and arrangements of the Local Arrangements Committee, headed by Brennan S. Thomas, and the city of Long Beach left no opportunity for anyone attending the conference to have anything but a most enjoyable time.

The major program of the conference started with a Kickoff Luncheon on

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Section Meetings

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Wednesday noon at which time the Long Beach Municipal Band provided entertainment, and Mayor George M. Vermillion, welcomed the delegates, 428 of whom attended.

Chairman H. Christopher Medbery opened the general technical sessions of the conference in the concert hall of the Municipal Auditorium with a paper prepared by Robert R. Shoemaker and Thomas J. Thorley, who spoke on "Subsidence in the Long Beach–Los Angeles Harbor Area—Its Relationship to Water Supply Utilities." Philip F. Walsh, reported on "Results of Investigation of Water Main Extension Rules and Regulations," and Earl E. Taylor discussed the "Economics of Safety."

Wednesday evening the traditional "All Divisions" Dinner was held at the Wilton Hotel. Television and movie stars provided the entertainment for the evening. Samuel B. Morris announced for the Fuller Award Committee its selection of Morris S. Jones, consulting engineer of Pasadena and formerly chief engineer and general manager of the Pasadena Water Dept., as its award nominee. H. Arthur Price announced the California Section Elliott Award recipients as Herbert S. Swanson, Herbert J. Chapton, and Carleton L. King of the Dept. of Water and Power of the City of Los Angeles, for their paper entitled "Design of Large Wye Branch Pipe" (tentatively scheduled for publication in the Journal this spring). President Maffitt presented Life Membership certificates to Arthur F. Ballou, Oakland; L. H. Chamberlain, Berkeley; Morris S. Jones, Pasadena; Chester H. Loveland, San Francisco; and Chester A. Smith, Glendale. A decision of the California Section Executive Committee to recognize in some way the work of former chairmen of the Section and that office's attendant honor culminated in the presentation to all living past-chairmen of the California Section an award or memento of their chairmanship consisting of a cast water works brass plaque set in a mahogany base (see cut). President Maffitt presented these awards to the following past-chairmen:

1924	Fred J. Klaus
1925	George W. Pracy
1927	Samuel B. Morris
1931	William W. Hurlbut
1934	Nelson W. Eckart
1939	Harry Reinhardt
1940	Fred S. Porter
1941	John S. Longwell
1942	Morris S. Jones
1943	James S. Peters
1944	Burton S. Grant
1945	C. Prough Harnish
1946	Carl M. Hoskinson
1947	Robert C. Kennedy
1948	H. Arthur Price
1949	Lauren W. Grayson
1950	Edward A. Reinke
1951	Gerald E. Arnold
1952	Joseph D. DeCosta
1953	Laurence E. Goit

The California Section Old Timers Citation, based generally on long membership in AWWA and retirement, were presented by Burton S. Grant to Arthur F. Ballou, Oakland; L. H. Chamberlain, Berkeley; Morris S. Jones, Pasadena; Chester H. Loveland, San Francisco; Chester A. Smith, Glendale; Joseph D. DeCosta, Oakland; Augustus Kempkey, Piedmont; Wilfred F. Langelier, Berkeley; Edward A. Reinke, Berkeley; E. O. Slater, Los Angeles; Stephen M. Dunn, Los Angeles; Claude T. Faw, Carmel; Carl F. Forgey, Oakland; Paul A. Giacomazzi, Santa Paula; Burt Harmon, Long Beach; John S. Longwell, Oakland; Fred C. Scobey, Berkeley; Nelson M. Launer, LaHabra; William Stava, San Francisco.

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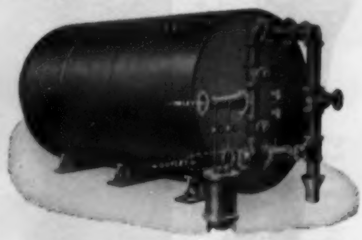

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Section Meetings

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The honor award certificates for the Gadgets and Kinks Exhibits, consisting of 43 entries of ingenious and practical devices invented by AWWA water utility employees and made in the utility shops, were presented by Ercel Cleminson, chairman of the judging committee, to: Howard L. Stauffer, Bell; C. L. Blanchar, Buena Park; and Charles C. Hatch, E. Pasadena for their gadgets, and to Fred L. Schraeder, Oakland, and Frank Pedley, Pomona, for their kinks. Sixteen golf prizes were awarded for low scores in the morning's golf tournament by H. G. Roberts of San Carlos and Claude T. Faw of Carmel.

A short address by President Maffitt highlighted a most entertaining program. Climaxing the conviviality of the evening, the delegates from the Hawaiian Islands presented a cascade of orchids and leis, quantities of Hawaiian fruits and nuts, swim suits for the ladies, sport shirts for the men, luau torches—an assortment of gifts too numerous to mention—to those in attendance. It was indeed a magnificent gesture of the generosity and fellowship of the Hawaiian members who sponsored this shipment for the conference.

On Thursday the technical sessions were divided into the parallel programs of the three divisions. The Business Management Div. with Frederick Schafer as chairman, Water Supply & Distribution Div. with Hilton H. Harris as Chairman, and Water Purification Div. with Henry J. Ongerth as chairman each met in a separate convention hall of the Municipal Auditorium.

Papers presented at the Business Management Div. session began with "How to Meet The Press" by Malcolm Epley, and "University Training for Administrators" by Henry Reining Jr. Ralph Foy presented a most interesting "old

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Section Meetings

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gossips" paper called "It's Rumored Management Says. . . ." The last paper of the morning session was by Howard B. Griffith, who discussed "Public Utility Employes Suggestion Plans."

At the Water Supply & Distribution Div., "Recommended Practice for Design and Manufacture of Prestressed Concrete Pipe" was discussed by Harold L. White and "Prestressed Concrete Tanks of The East Bay Municipal Utility Dist." by J. W. Trahern. A "Suggested Nontechnical Manual on Corrosion for Water Works Forces" was offered by L. B. Hertzberg. William R. Seeger presented a paper on the details of the "Design and Construction of Peters Dam and Appurtenant Works." Roland Triay ended with "Pump System Analysis and Design Methods Used in the Los Angeles Water System."

For the Nostalgic: California Reviews Its 1934 Meeting at Long Beach

The Water Purification Div. papers included "Some New Slants in Sedimentation" by J. E. McKee, and a paper by F. M. Middleton on "Identification of Organic Pollutants Affecting Drinking Water Quality." "Practical Methods for Measurement and Removal of Radioactive Products in Water" was discussed by Harold Pearson, and the final paper was "Vacuum Degasification of Water for Taste and Odor Control" by Bernard Schiller.

On Thursday afternoon all Divisions combined again into a general session which took the form of a Water Works Forum moderated by Lauren W. Grayson. Problems discussed were: "Fishing on Reservoirs" led by Paul Beerman and Blair I. Burnson; "Utility Location On Freeways" led by Patrick J. Maloney; "Licensing Water Treatment Works Operators" led by Joseph M. Sanchis; and "Valves—The Right One at the Right Place" led by Duncan A. Blackburn.

On Friday the general session in the morning began with a paper by Emil Mamrelli on "Consumer Service Requirements." Raymond A. Hill presented a very comprehensive paper on "Water Storage—Surface and Underground." A discussion on "Planning and Legal Aspects of Water Supply in California" was presented by Ransom Chase, Henry Holsinger, and C. A. Griffith. Fred S. Porter discussed the new facility of the Long Beach Water Dept. in a paper titled "New Meter Repair Shop and Testing Facilities." The final presentation of the technical sessions was by AWWA President Maffitt, who discussed nationwide "Water Works Problems."

The Annual Banquet of the California Section sponsored by the Water & Sewage Works Manufacturers Assn. took the attention of all those in attendance for the evening.

In addition to the social events in which all shared, a special round of entertainment for the ladies was prepared and executed by the Ladies Hospitality Committee under the capable guidance of Mrs. Brennan S. Thomas. Wednesday afternoon a Sunset Tea was provided at the Wilton Hotel through the generosity and courtesy of the Water & Sewage Works Manufacturers Assn. Marian Pratt, who provides "bird voices" for the movies, demonstrated to the ladies how she did it. On Thursday buses left for Knott's Berry Farm and its very unique mother lode ghost town, most of which has been moved bodily in its original form from the gold mining country to its present location. The chicken dinner served at noon left nothing to be desired. At the Friday noon lunch in the Supper Room of the Lafayette Hotel a capable

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Section Meetings

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decorator demonstrated table arrangements and other decorations.

H. F. JERAULD
Secretary-Treasurer

Alabama-Mississippi Section: The Section's seventh annual meeting was held at the Tutwiler Hotel in Birmingham, Oct. 24–27, with 311 members and guests registered. The program for the four days was planned by the Program Committee under the leadership of W. E. Hooper, chairman.

A "Get Acquainted Party" the first evening and similar brief periods for relaxation were scheduled daily by the Club Room Entertainment Committee, with Ernest Bryan as chairman, and the Local Arrangements Committee under E. C. Smith.

The Monday morning session was called to order by W. H. H. Putnam, Section chairman, after which Mayor J. W. Morgan, extended a warm welcome to Birmingham, and AWWA Secretary Harry E. Jordan addressed the assembly. The vice-president of the Coca-Cola Co., Edgar J. Forio, gave the group the basic concepts of public relations in down-to-earth language understandable to all.

As Birmingham is the world's largest cast-iron pipe producer, the afternoon visit made by the water men to two of the pipe foundries was most appropriate. Two methods of producing cast-iron pipe were observed step by step, from raw material to finished pipe. This visit was made through the courtesy of the Birmingham Cast-Iron Pipe & Foundry Assn.

On the morning of the second day, the program opened with the showing of the colored motion picture of the H-bomb test filmed during "Operation Ivy." "What the Section Can Do for You" was the title of the first paper of the day, presented by Jess L. Haley, vice-chairman of the Section. "Insurance and Liabil-

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Section Meetings

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ity" was discussed jointly by insurance men Ed T. Beal and Z. H. Tackett. A delicious lunch of barbecued chicken and pork at Birmingham's Water Filtration Plant was provided by the Water Works Board. After lunch, guided tours were made of the filtration plant facilities and raw water pumping station.

Tip H. Allen was the first speaker on the last day's program. He gave a humorous and thought-provoking talk on "Water Rate Trends." The question, "What Is a Manager?" was ably answered by B. R. Morley, University, Ala. During the business meeting, which completed the morning's program, the following officers were elected to guide the Section's activities in the coming year: Jess L. Haley, chairman; W. U. Quinby, vice-chairman; C. W. White, secretary-treasurer.

The afternoon panel discussion was moderated by H. L. Burns. A. N. Beck spoke on "Short Courses for Water Works Operators." This was followed with "Construction Equipment and Methods" by C. C. Williams. "The Economics of Meter Repairs" was presented by Ed E. Love. The last subject of the discussion was "Safety" by R. C. Campbell. A number of questions with some lively discussion resulted.

Some wonderful entertainment was provided for the ladies by the Ladies Entertainment Committee, of which Mrs. Estelle Putnam was chairman. It appears that offering a good program for the ladies and urging them to come results in the Section's meetings being better attended, and everyone has a more enjoyable time.

The meeting was brought to a close with a banquet followed by dancing. During the banquet, the chairman of the Fuller Award Committee, George W. Godwin, announced that Tip H. Allen of Canton, Miss., had been nominated to receive the George W. Fuller Award.

C. W. White
Secretary-Treasurer

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Welsbach Corp., Kitson Valve Div.
Storage Tanks; see Tanks
Strainers, Suction:
James B. Clow & Sons
M. Greenberg's Sons
Johnson, Edward E., Inc.
R. D. Wood Co.
Surface Wash Equipment:
Cochrane Corp.
Permutit Co.
Swimming Pool Sterilization:
Everson Mfg. Corp.
Omega Machine Co. (Div., B-I-F Industries)
Proportioneers, Inc.
Wallace & Tiernan Inc.
Welsbach Corp., Ozone Processes Div.
Tanks, Steel:
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Bethlehem Steel Co.
Chicago Bridge & Iron Co.
R. D. Cole Mfg. Co.
Pittsburgh-Des Moines Steel Co.
Tapping-Drilling Machines:
Hays Mfg. Co.
Mueller Co.
A. P. Smith Mfg. Co.
Tapping Machines, Corp.:
Hays Mfg. Co.
Mueller Co.
Welsbach Corp., Kitson Valve Div.
Taste and Odor Removal:
Cochrane Corp.
General Filter Co.
Industrial Chemical Sales Div.
Infilco Inc.
Permutit Co.
Proportioneers, Inc.
Wallace & Tiernan Inc.
Welsbach Corp., Ozone Processes Div.
Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Wallace & Tiernan Inc.
Turbines, Steam:
DeLaval Steam Turbine Co.
Turbines, Water:
DeLaval Steam Turbine Co.
Valve Boxes:
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Mueller Co.
Pacific States Cast Iron Pipe Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
Trinity Valley Iron & Steel Co.
R. D. Wood Co.
Valve-Inserting Machines:
Mueller Co.
A. P. Smith Mfg. Co.
Valves, Altitude:
Ross Valve Mfg. Co., Inc.
Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
DeZurik Shower Co.
M. Greenberg's Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
R. D. Wood Co.
Valves, Detector Check:
Hersey Mfg. Co.
Valves, Electrically Operated:
Belco Industrial Equipment Div.
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
Valves, Float:
James B. Clow & Sons
Ross Valve Mfg. Co., Inc.
Valves, Gate:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Pacific States Cast Iron Pipe Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.
Valves, Hydraulically Operated:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
DeZurik Shower Co.
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Mueller Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.
Valves, Large Diameter:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.
Valves, Regulating:
Crane Co.
DeZurik Shower Co.
Foster Eng. Co.
Mueller Co.
Ross Valve Mfg. Co.
Valves, Swing Check:
Chapman Valve Mfg. Co.
James B. Clow & Sons
Crane Co.
Darling Valve & Mfg. Co.
M. Greenberg's Sons
M & H Valve & Fittings Co.
Mueller Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.
Waterproofing
Gulf States Asphalt Co.
Inertol Co., Inc.
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Water Supply Contractors:
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Water Testing Apparatus:
Wallace & Tiernan Inc.
Water Treatment Plants:
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American Well Works
Belco Industrial Equipment Div.
Chain Belt Co.
Chicago Bridge & Iron Co.
Cochrane Corp.
Dorr-Oliver Inc.
General Filter Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco Inc.
Permutit Co.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Wallace & Tiernan Inc.
Welsbach Corp., Ozone Processes Div.
Well Drilling Contractors:
Layne & Bowler, Inc.
Well Screens
Johnson, Edward E., Inc.
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Dresser Mfg. Div.
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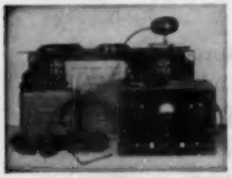

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